SANYO

SANYO's leading-edge technologies support advances in portable electronic equipment.

With the increasingly wide adoption of 3G and later cell phone infrastructure, cell phones are featuring even more advanced and diverse functionality. The speed with which multimedia functionality is being adopted is increasing, and that trend is not limited to Japan, but is spreading worldwide.

SANYO has, for the first time in the industry, adopted a 1/9-type CCD image sensor for cell phones. SANYO is moving towards the megapixel age in camera cell phones, starting with the chip size package (CSP). Furthermore, SANYO continues to contribute to the development of the cell phone market with efforts such as developing SANYO's unique Integrated System in Board module technology that achieves even higher densities and thinner form factors, developing QVGA OLED displays, the Easy Radio IC™ series that makes it easy to include a radio receiver in portable equipment, providing an extensive lineup of motor drivers for zoom, autofocus, and other functions in cell phone cameras, and developing power supply ICs for high pixel count CCDs.

Higher pixel counts, further miniaturization, and lower power. To respond to these market needs and to provide new areas of added value for our customers' products, SANYO uses their subtle technological arts to expand their lineup of diverse chipsets and individual devices.

Notes on Package Types and Naming
The package names used in this documentation are designed to indicate rough classification of the packages used, and do not necessarily indicate the formal name of each individual package.
Refer to the delivery specifications document for the particular product for the package dimensions figure and the formal name of the package.
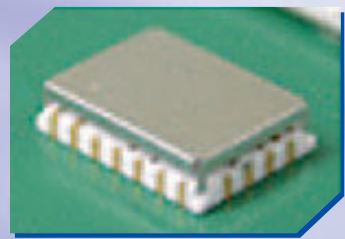
CONTENTS

SANYO Group Cell Phone Components

Mega Pixel CCD Camera Module

Small discrete devices

FEM
(Front End Module)

POSCAP

Vibration Motor
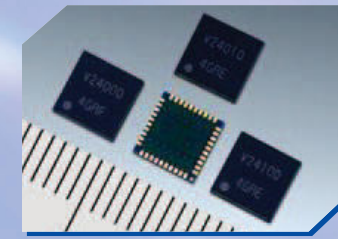
FM Tuner IC

Amorphous Optical Sensor

Sound Generator IC

SAW Filer

ASM
(Antena Switch Module)
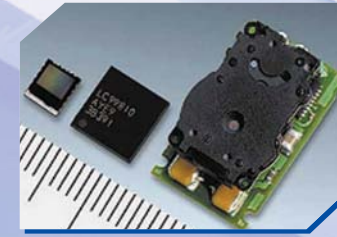
Die Electric Filter & Duplexer
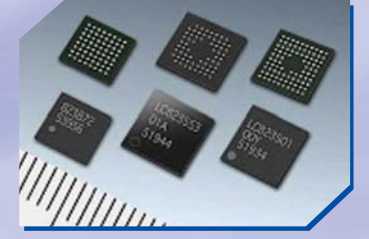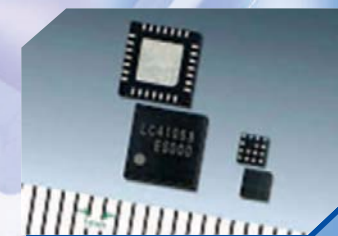
Charge Pump

DC/DC

LED Driver

Integrated System in Board

SAW Duplexer

RGB Chip LED
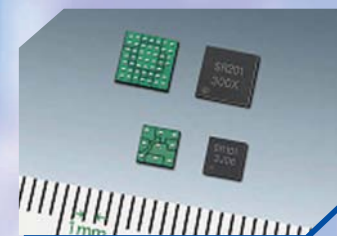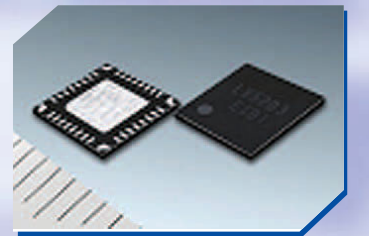
LCD
(SANYO EPSON IMAGING DEVICES CORPORATION)

Battery

Speaker

Module technologies that achieve high-density and thinner form factors

Integrated System in Board

Integrated System in Board is a type of SiP (system in package) technology, and is a module technology that achieves high densities and thinner form factors by using SANYO's unique substrate and mounting technologies. The Integrated System in Board lineup consists of three types of process: ISB-Solo, ISB-Duo, and ISB-Quad. Which process is used is selected based on the application.

In addition to standard products, customer specified circuit blocks can also be converted to Integrated System in Board using an optimal process, thus creating a new module device in a short time.

Integrated System in Board Process Lineup

ISB-Solo

- Thickness of only 0.45 mm (0.65 mm if resistors are included) realizes excellent thermal radiation and short development TAT
- Optimal for SiP implementation of small-scale block that includes semi-power semiconductors.

■ Assembly structure examples

■ Application example (Cell phone charger circuit block)

Earlier mounting

Integrated System in Board

Integrated System in Board

Top surface

Back surface

$4.45 \times 4.45 \times 0.65$ mm^3

Mounting area reduced by 80%

ISB-Duo

- Adopts unique SANYO-developed 0.2 mm thickness high-density substrate (2 layers)
  Line 40 µm / Space 40 µm at 25 µm thickness copper foil,
  Via diameter 100 µm / Via land diameter 150 µm
- Thickness of only 0.53 mm (0.73 mm if resistors are included) realizes high-density mounting
- Optimal for SiP implementation of high-frequency (up to 10 GHz) blocks, blocks that require performance or EMC workarounds based on component placement/wiring pattern, and blocks that require partial high-density mounting.

■ Assembly structure examples

■ Application example (Clock detector block)

Earlier mounting

Integrated System in Board

Integrated System in Board

Top surface

Back surface

$4.3 \times 4.3 \times 0.73$ mm^3

Mounting area reduced by 58%

ISB-Quad

- Adopts unique SANYO-developed 0.24 mm thickness high-density substrate (4 layers)
- Thickness of only 0.6 mm realizes high-density mounting
- Optimal for SiP implementation of high-frequency (up to 10 GHz) blocks, blocks that require performance or EMC workarounds based on component placement /wiring pattern, and subsystems that require high-density mounting.
- Chip-on-Board type

■ Assembly structure examples

ISB-Duo

Passive components
(resistors and capacitors)

WS-CSP

Flip Chip

ISB-Quad

0.24 mm

Noise suppression effect (measured)

Reasons noise can be reduced by Integrated Sysytem in Board

- Reduced wiring area due to implementation as miniature modules
- Integration of noise reducing components
- Supply voltage stabilization by using dedicated layers for power supply and ground

LSI

Integration of noise reducing components

Dedicated power supply/ground layer
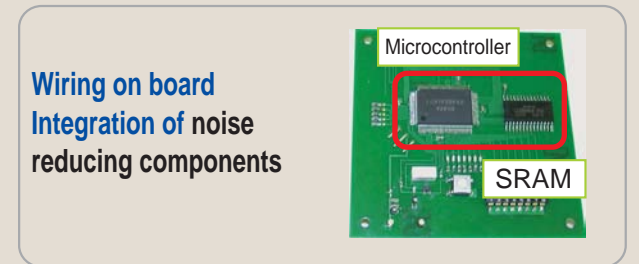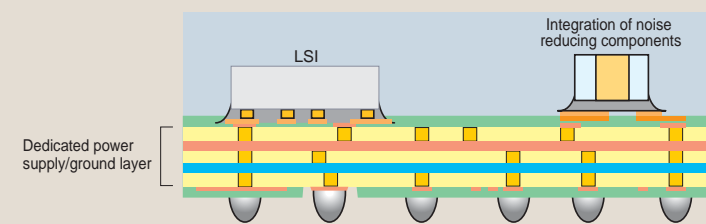
Wiring on board
Integration of noise reducing components

Microcontroller

SRAM

Noise is reduced significantly

Surface scan using a field probe

ISB-Duo (2-layer ISB)
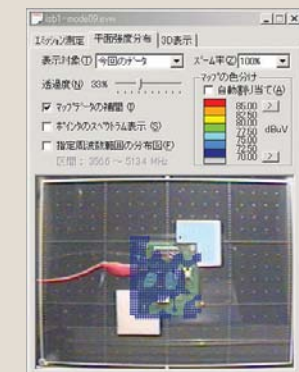
Separate microcontroller and SRAM
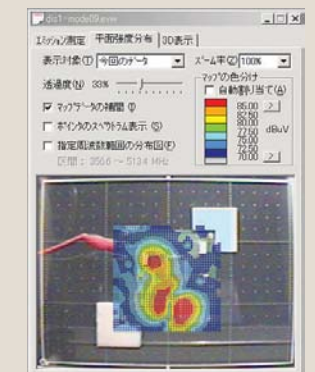
Integrated System in Board stack structure (high-density mounting)
Integration of noise reducing components

10 mm $\times 10$ mm

Microcontroller
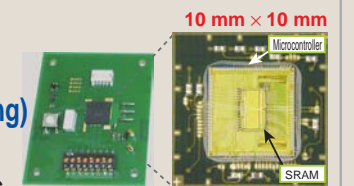
SRAM

■ Evaluation results using a microcontroller and SRAM
(Surface probe method - 30 MHz to 1 GHz)

Heat dissipation effect (simulation)

Typical BGA

Integrated System Board package

Integrated System Board that dissipates heat

97
89
81
73
65
57
49
41
33
25

Maximum temperature
92.7 [°C]

Temperature difference
38.4°C

Temperature difference
52.3°C

Maximum temperature
54.3 [°C]

Maximum temperature
40.4 [°C]
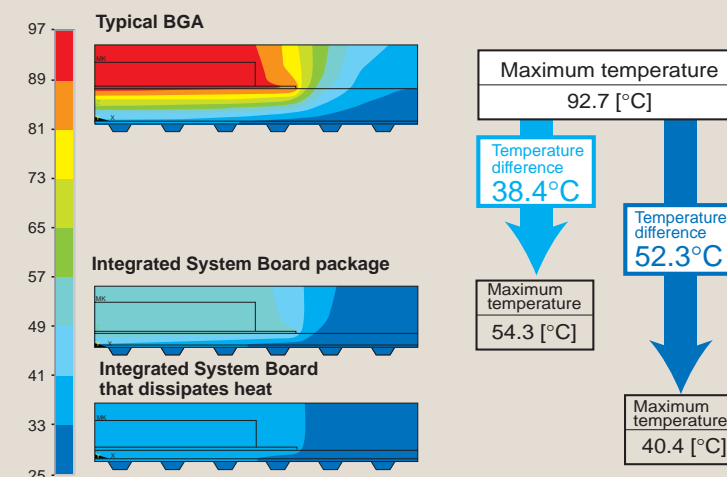
Analysis conditions

Chip heat generation	3 [W]
Chip size	$4 \times 4 \times 0.3$ [mm^3]
Land size	$5 \times 5 \times 0.03$ [mm^3]
Atmospheric temperature	25 [°C]
Cooling conditions	Ideal cooling of the solder lower surface; 25 [°C]
Analysis model	1/4 model (since symmetrical)

Integrated System in Board Application Products (Standard Products)

Here we introduce examples of ICs used for cell phones implemented as modules using Integrated System in Board.

Thin Form, Miniature 1 or 2 Channel DC/DC Converter Power Supplies

SR Series

These products combine a step-up DC/DC converter, n-channel power MOSFET, and Schottky barrier diode devices in a single module. A switching step-up power supply can easily be implemented with just the addition of external voltage setting resistor, coil, and capacitor components.

■ Compared to discrete components with Integrated System in Board

Earlier mounting   Integrated System in Board

Integrated System in Board

Top surface   Back surface
$3.4 \times 3.4 \times 0.65$ mm^3

Mounting area   reduced by 35%

■ Block Diagram (SR10010)

Di
TR
EXT   VDD
CE   IC   FB
GND
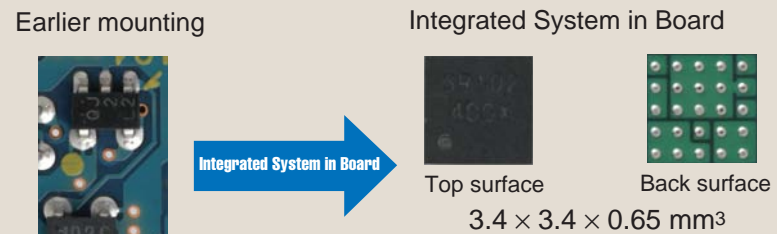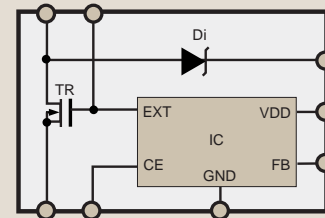
■ Product lineup

Type No.	Number of channels	Type	Oscillator frequency	Withstand voltage	Size	Status
SR10010	1ch	Step-up type	180 kHz	20 V		ES samples/MP support
SR10020			300 kHz	20 V		ES samples/MP support
SR10030			180 kHz	30 V	$3.4 \times 3.4 \times 0.65$ mm^3	ES samples/MP support
SR10110			100 kHz	20 V		In volume production
SR10210			100 kHz	20 V		In volume production
SR103XX		Step-down type	—	—	—	Under development
SR20010	2ch	– power supply type	180 kHz	20 V	$5.0 \times 5.0 \times 0.65$ mm^3	ES samples/MP support

Earlier mounted

Integrated system in Board
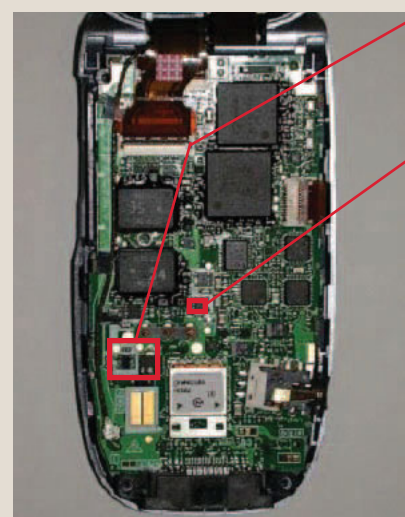
Charge control circuit
$10.0 \times 10.0 = 100.0$ mm^2
+
Regurator IC
$3.0 \times 3.0 = 9.0$ mm^2

Mounting area   reduced by 80%

Size: 109.0 mm^2 → 19.80 mm^2

ISB-E17-0
$4.4\ 5 \times 4.45 = 19.80$ mm^2
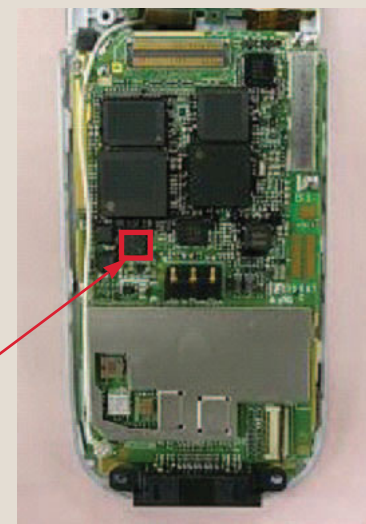
2002   **2004**

NTSC/PAL encoder+Video driver+Audio codec+Speaker amplifier

LC822964

New product

Featuring

■Video Block

● One output system
  Low-cost version specialized for cell phones
● Supports a wide variety of input data (ITU-R601/SQ)
● No output coupling capacitors required
● High performance
- Switching noise does not appear on the screen due to the use of charge pump technology
- Voltage sag does not occur
● Built-in 6th order low-pass filter: fc = 7.5 MHz
● Standby mode power consumption: 0 μA

■Audio Block

● D/A converter signal-to-noise ratio: 98 dB (A weighting), THD: 84 dB at 48 kHz
● A/D converter signal-to-noise ratio: 90 dB (A weighting), THD: 80 dB at 48 kHz
● Programmable ALC/noise gate
● Stereo/monaural microphone interface
● Built-in headphone driver
● Low power consumption
● 450 mW output (Vcc = 3.6 V, 1 kHz, THD = 1%)
● Power saving and standby functions

■ Block Diagram

Audio I/O block

Microphone amplifier

Audio Codec

ADC   ALC

Speaker amplifier LA74220C

I^2S

DAC   Volume   Speaker amplifier

Heaphone amplifier

TV output block

NTSC/PAL Encoder LC822962

IIC I/F   Timing Generator

CCIR601

ITU-R601/SQ I/F   NTSC/PAL Video Encoder

75 Ω Video Driver LA73074C

Composit video output
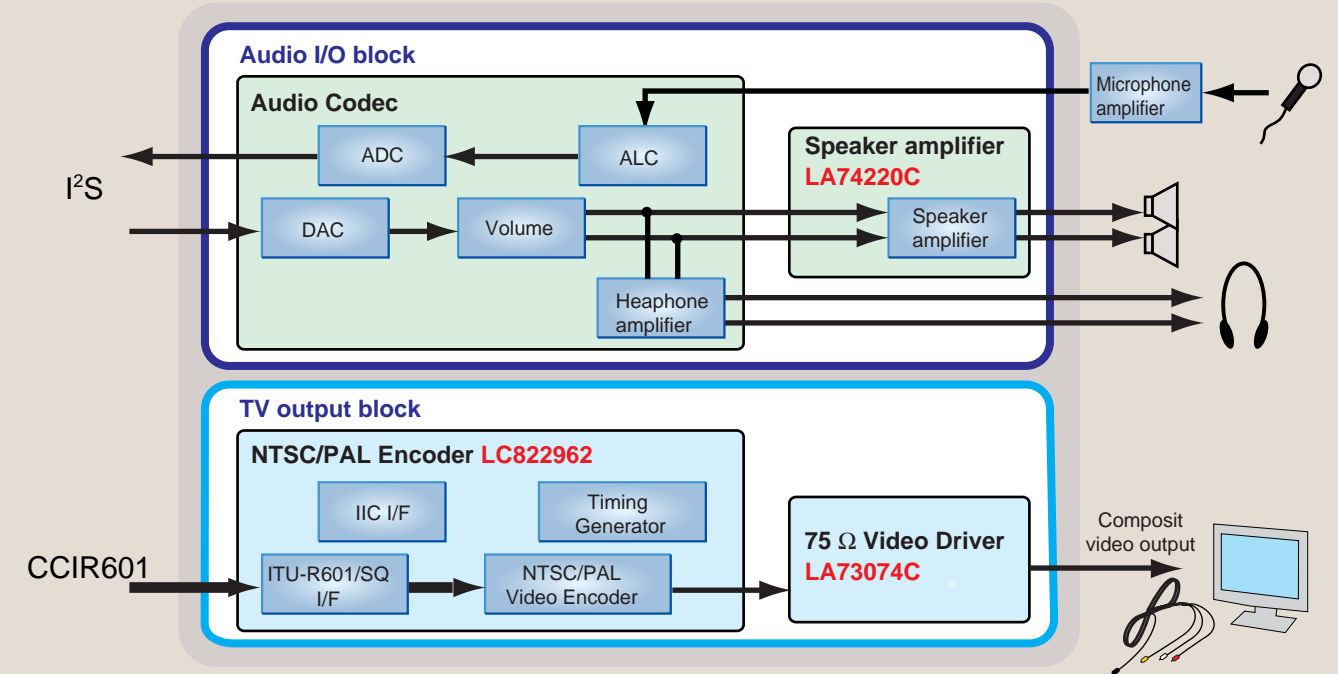
Current mounting area
84.88 mm^2 + Passive components

● **Sound I/O Block**

Audio codec
$5.2\times5.2\times0.8$ mm^3

Speaker amplifier
$5.0\times5.0\times0.8$ mm^3

● **TV Output Block**

NTSC/PAL encoder
$5.0\times5.0\times1.0$ mm^3

Video driver
$2.8\times2.8\times0.8$ mm^3

Mounting area can be reduced by over 50%

Integrated System in Board
45 mm^2 (6.0×7.5 mm^2)

Sound I/O + TV output

Cell Phone Block Diagram Examples

Since the next generation of cell phones will include an even wider variety of functions than ever before, we expect that dedicated multimedia processors and devices will be required.
SANYO provides a wide range of devices required by next generation cell phones, and can provide powerful support for your cell phone development efforts.

LED Driver — P26, P27

LV5202PL — Under development
13-ch 9-LED driver

LV5203FN — Under development
13-ch 11-LED driver

LV5204PL — Under development
13-ch 11-LED driver

LV5213LP — New product
3-ch RGB-LED driver

High-Efficiency Charge Pump Type

LC410591 — Under development
4 LEDs

LC410592 — Under development
7 LEDs
For main LCD backlights

64 or 128-Voice Polyphony Sound Generator IC Series — P20

LC823872 — New product
These ICs can generate up to 128 sounds at the same time and include 3D Audio functions.
This is the latest sound generator IC that even supports new melody formats such as Mobile XMF, and provides the highest functionality in the series as an independent sound generator product.

Sound Generator + Audio Compression IC — P20

LC823553 — New product
These ICs can generate up to 64 sounds at the same time and include 3D Audio functions.
This is a combined product that integrates ultralow-power MP3 and AAC decoder functions, and is optimal for use in cell phones for true audio aficionados.

LC823501 — New product
This model corresponds to a low-price version of the LC823553 with certain functions removed, and is a combined product that integrates an ultralow-power MP3 decoder with a sound generator IC that supports 64-voice polyphony.

MP3 and WMA Decoder IC — P21

LC823231
By using dedicated circuits with a hardwired structure to implement the MP3 and WMA decode functions, these ICs achieve extremely low power levels.

MP3/AAC/AAC+Decoder

LC82335X — Under development

1-Chip FM/AM Tuner ICs — P16 to P19

LV24020 — New product

LV24010 — New product
(FM+RDS)

LV24003 — New product
(FM+source selector+ headphone amplifier)

LV24100 — New product
(FM+AM)
These revolutionary devices are self-contained FM radio ICs that require no external components.

Earphone/Microphone Solutions — P24

S.T.F.D. — Under development
(Single Transducer Full Duplex)
SANYO has developed a chip that supports communication with just an earphone.
● Conversation is possible even without a microphone
● Achieves clearly audible conversation even in noisy environments

Integrated Audio/Video ICs — P9

LC822964
Integration of an NTSC/PAL encoder, video drivers, an audio codec, and a speaker amplifier IC in a single package using ISB technology. The mounting area can be reduced by 50% or more.

NTSC/PAL Encoder — P23

LC822961
LC822963 — New product
LC822971 — Under development

The cell phone display can easily be connected to a TV for viewing.
These devices support a wide variety of input data rates (ITU-R601/SQ).
The LC822971 includes 16 Mbits of SDRAM and allows the CPU to draw graphics without concern for the TV display rate.

Video Driver — P22

LA73074CL — New product

Ultraminiature Package 2-Phase Stepping Motor Drivers — P30, P31

LB1906CL
LB1935CL
LB1935T

1-ch Low-Saturation Forward/Reverse Motor Driver

LB1938T

2-Phase Excitation Motor Driver

LB1801CL — New product

Constant Current Driving Motor Driver with 1-ch H Bridge and Thermal Shutdown Curcuit

LB1941CL
LB1941T

2-ch stepping + 1-ch Constant Current Forward/Reverse Motor Driver IC

LB8682CL

1.5-ch Constant Current Forward/Reverse Motor Driver IC

LB8683CL — Under development

Auto Foucus Piezo Actuator

LV8071LG — Under development

Cell Phone 1/4-Type 3.2 MP CCD Camera Chipset — P12 to P15

LC99359(CCD)+ LC99812(DSP) — New product
The extensive depth of field provided by these camera modules means the user never has to worry about focus. These camera modules are optimal for camera cell phones that need to provide easy and convenient imaging.

Cell Phone 1/7-Type VGA Resolution CCD Camera Chipset

LC99268(CCD)+ LC99809(DSP)
These camera modules are optimal for low-end camera cell phones. These ultraminiature camera modules are so small that they do not interfere with the design of cell phone.

Cell Phone 1/9-Type CIF Resolution CCD Camera Chipset

LC99267(CCD)+ LC99807(DSP)
These modules are optimal for sub-camera of video conferencing cell phone products.

Terrestrial Broadcast One-Segment OFDM Demodulator IC — P22

LC74112 — Under development
The adoption of diversity synthesis technology makes stable reception possible.

Terrestrial Broadcast One-Segment Frequency Conversion IC

LA8101 — Under development
The adoption of direct conversion technology obviates the need for a SAW filter and supports miniaturization.

Block diagram labels

Charge pump — LED driver
FM/AM tuner
Headphone
KEY
Sound generator
Audio compression decoder
SP
MIC
Audio codec
NTSC/PAL encoder — Video driver
TV
Display controller
LCD display
RF
Baseband processor (CPU)
Application processor
Motor driver (Miniature series)
Autofocus Optical zoom
Megapixel CCD camera module
Sub-camera CIF/VGA
Charge pump — P28, P29
Memory
Amorphous optical sensors — P32, P33
Flash memory
External memory
Graphic memory
Battery
Power supply control
Integrated System in Board — P8, P9
Terrestrial broadcast one-segment OFDM demodulator
Frequency conversion
One-segment tuner
Diversity antenna

*: A separate coil is required for applications that include an AM radio

Frame Transfer Full-Color CCD Sensors

SANYO fabricates frame transfer (FT) CCD sensors using unique technologies with ultrafine design rules and provides them as modules assembled using advanced leading-edge mounting technologies.
SANYO makes a point of providing fine and delicate semiconductor devices in forms that our customers will find approachable and easy to use.

Frame Transfer CCD

Achieves the industry's smallest optical size class by using the frame transfer CCD, which makes it possible to reduce feature sizes while maintaining sensitivity.
Sensitivity was increased by adopting a simple single-layer gate gap structure and thin-film polysilicon.

FT-CCD	CMOS	IL-CCD
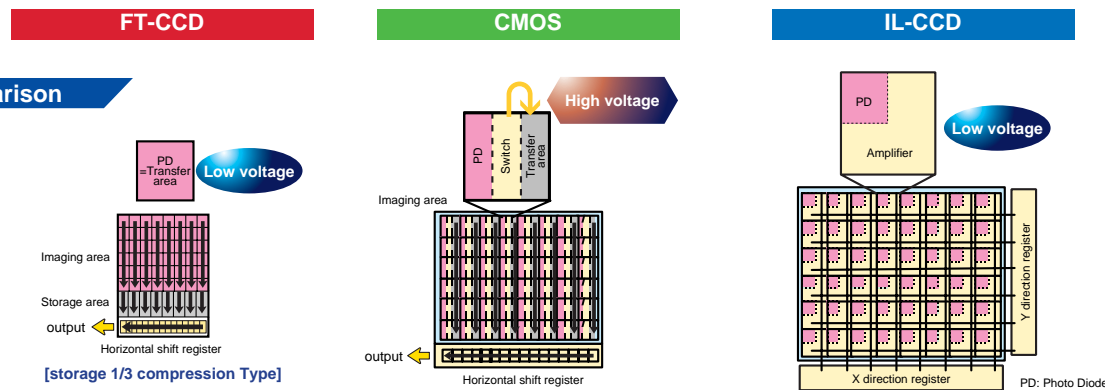
Device Density Comparison

Comparison of chip sizes required to acquire the same imaging device area

High sensitivity

PD =Transfer area — Low voltage
Imaging area
Storage area
output
Horizontal shift register
[storage 1/3 compression Type]

PD — Switch — Transfer lines — High voltage
Imaging area
output
Horizontal shift register

PD — Amplifier — Low voltage
Y direction register
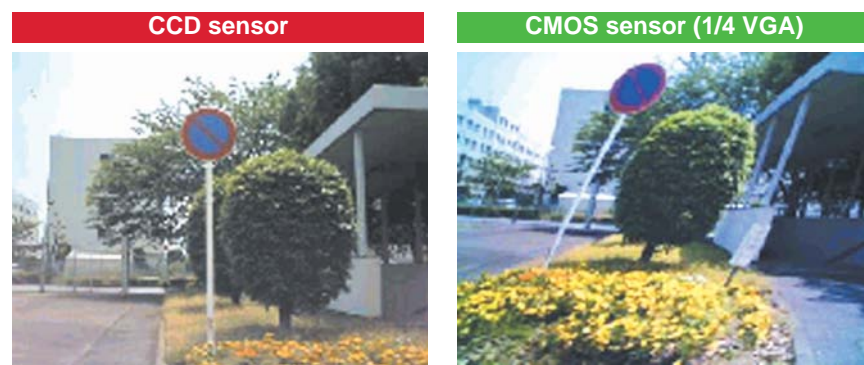X direction register
PD: Photo Diode

Cross Section Comparison

The FT CCD method uses no elements that block the entrance of light, and thus they can capture light from a wider range of incidence angles.

Reducing the device height is possible

Micro Lens
Photo Diode

Micro Lens
Photo Diode

Micro Lens
P+ N+ N+   P+ N+ N+
Photo Diode
P-Sub
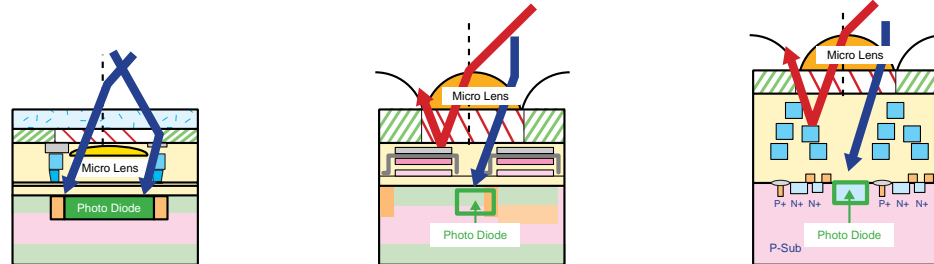
Comparison of Differences in Electronic Shutter Types
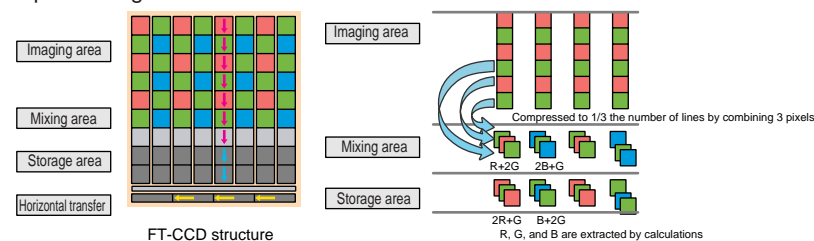
CCD sensor	CMOS sensor (1/4 VGA)

Newly developed

In the 1.0-MP CCD, SANYO developed a new charge accumulation method.
Low moire, high sensitivity, and a high frame rate achieved by pixel addition during preview and spatial filter processing.
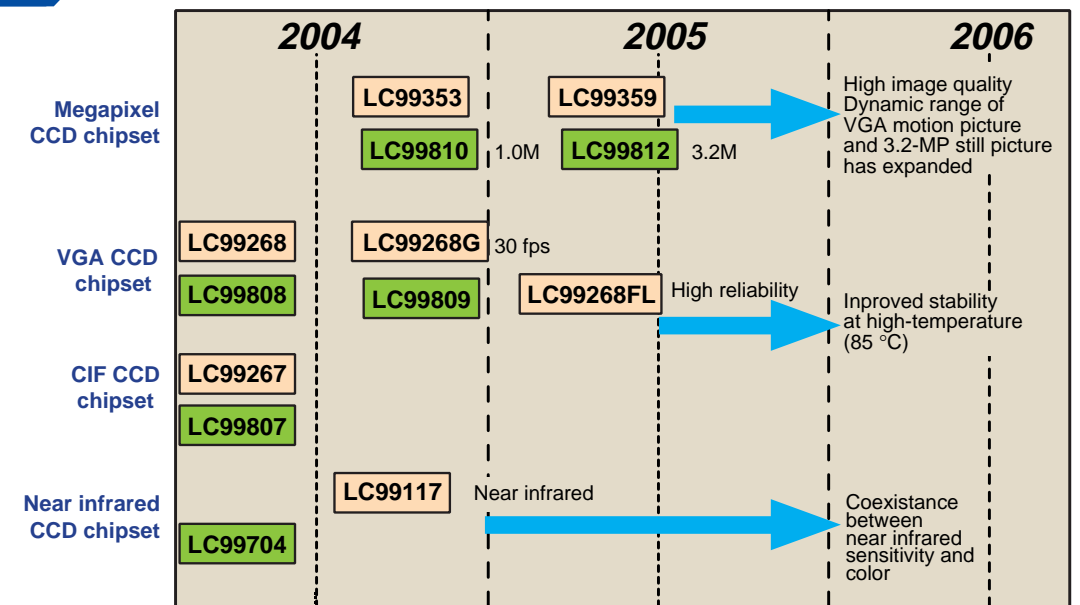
High sensitivity

Low moire

Imaging area
Mixing area
Storage area
Horizontal transfer
FT-CCD structure

Imaging area
Mixing area
Storage area
Compressed to 1/3 the number of lines by combining 3 pixels.
R+2G   2B+G
2R+G   B+2G
R, G, and B are extracted by calculations

Multifunction DSP chip

CCD drive circuit and image processing implemented in a single package

A charge pump type voltage step-up circuit that features minimal noise generation, and the supply voltages required for system drive are generated efficiently with just the supply of a single +2.9 V power supply. This design is also effective at achieving reduced power consumption.
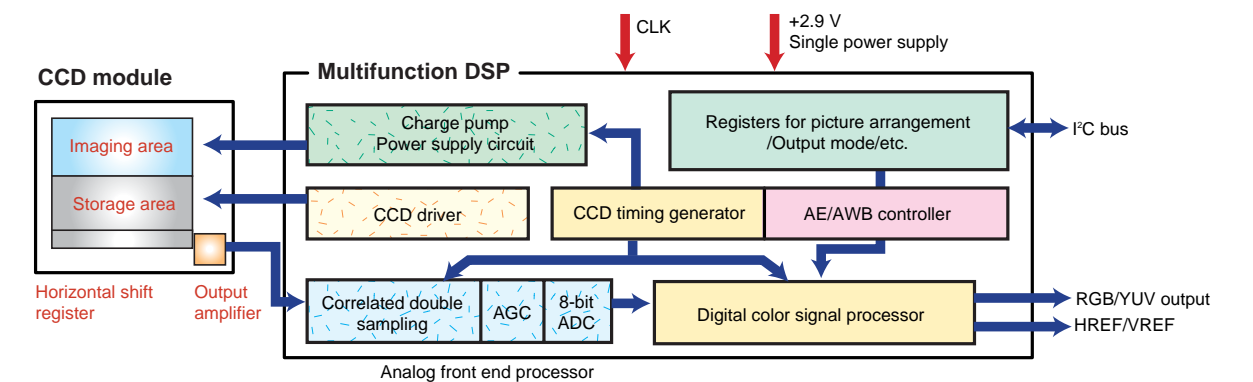SANYO implemented, in a single package, the timing generator circuit required for system drive and all the analog and digital processing required to accept the CCD output by taking advantage of the SANYO CMOS analog/digital hybrid process and MCP (multi-chip package) technologies.

Roadmap

	2004	2005	2006
Megapixel CCD chipset	LC99353 / LC99810	LC99359 / LC99812	High image quality Dynamic range of VGA motion picture and 3.2-MP still picture has expanded
		1.0M 3.2M	
VGA CCD chipset	LC99268 / LC99808	LC99268G / LC99809	LC99268FL	Inproved stability at high-temperature (85 °C)
		30 fps	High reliability	
CIF CCD chipset	LC99267 / LC99807		
Near infrared CCD chipset	LC99704	LC99117	Coexistance between near infrared sensitivity and color
		Near infrared	

Chip Set	Color/B&W	Resolution		Sensitivity		Dynamic Range	Frame Rate	Output
		Still	Motion	Still	Motion	Motion	Motion	Motion
LC99359	Color	3.2M	VGA	Low	High	Normal	30	Digital
LC99268FL	Color	VGA	VGA	High	←	Wide	15	Digital
LC99117	B&W	CIF	CIF	Very High	←	Wide	30	Digital

CCD Module Basic Structure Example

CLK
+2.9 V Single power supply

CCD module
Imaging area
Storage area
Horizontal shift register
Output amplifier

Multifunction DSP
Charge pump Power supply circuit
CCD driver
Correlated double sampling — AGC — 8-bit ADC
Registers for picture arrangement /Output mode/etc. — I²C bus
CCD timing generator — AE/AWB controller
Digital color signal processor — RGB/YUV output — HREF/VREF
Analog front end processor

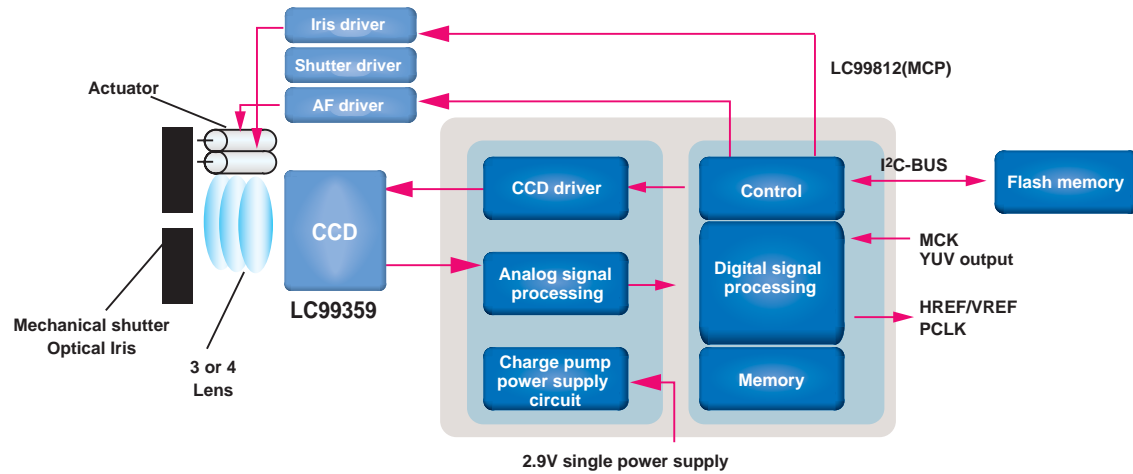# 1/4-Type 3.2 MP CCD Camera Module for Cell Phones

HyperEye™

The stable and reliable image quality provided by CCD image sensors. The simultaneity of an image in which the whole image was captured at the same instant. A great depth of field that makes focusing unnecessary.

Even if the camera is only a cell phone cameras, the instant captured is, for the user, still an important instant in their life. This is why SANYO is committed to providing products that make no compromises.

1/4-Type 3.2 MP CCD Chipset

LC99359+LC99812

HyperEye™

Chipset Example

- Iris driver
- Shutter driver
- AF driver
- Actuator
- CCD driver
- Control
- CCD
- LC99359
- Analog signal processing
- Digital signal processing
- Charge pump power supply circuit
- Memory
- Mechanical shutter Optical Iris
- 3 or 4 Lens
- LC99812(MCP)
- I²C-BUS
- Flash memory
- MCK YUV output
- HREF/VREF PCLK
- 2.9V single power supply

Introducing the Component Devices

3.2 MP Frame Transfer CCD Image Sensor

LC99359

New product

- ● Diagonal: 1/4 type
- ● 3.2M pixels
- ● Effective pixels: 2079 × 1554 (H × V)
- ● Square pixels (1.8 × 1.8 μm^2)
- ● Color filters: Primary color (RGB) Bayer
- ● Package: CSP

High performance DSP for LC99359

LC99812

New product

- ● On-chip CCD driving timing generator and CCD driver
- ● On-chip power supply circut for driving charge pump type CCD
- ● AGC
- ● YUV and RGB output signal
- ● Power saving mode
- ● Built-in smear correction circuit, automatic dropout correction circuit
- ● Shading correction
- ● Noise control circuit
- ● Timing generator to drive the mechanical shutter
- ● Scaling and zoom functions
- ● Timing generator for auto-focus control, auto-exposure control, autowhite balance control, and mechanical iris control
- ● Supply voltage: 2.9 V (single-voltage operation)
- ● Package: BGA128

Great Depth of Field

This is a truly easy-to-use camera, since it has a wide range, from close at hand to far away, over which subjects are in focus, and thus it is difficult to accidentally create blurred out of focus images.

7 m

9 cm

6 m

3 m

Far　　　**Near**

When used in applications such as cell phones, this camera can easily take photographs such as the one shown above, since the user can check a preview image while shooting.
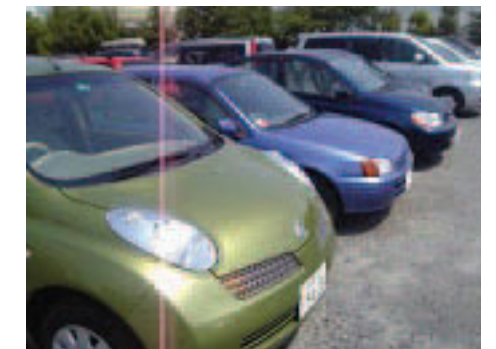
Mechanical Shutter

Smear does not occur during still imaging when used in a module that includes a mechanical shutter.

Module that includes a 2-stage (f/3.5 and f/7.0) optical aperture

Including a mechanical shutter

Not including a mechanical shutter

Modules that use this CCD Chipset

	IGT99353M-SUB1	IGT99268GC-ST1	IGT99268C-ST1	IGT99267J-ST	IGT99267J-SUB
Photo					
Type	1/4.5 1.0 MP	1/7 VGA	1/7 VGA	1/9 CIF	1/9 CIF
CCD sensor	LC99353	LC99268GFB	LC99268FBX	LC99267FB	LC99267FB
DSP	LC99810	LC99809	LC99808	LC99807	LC99807
Size		8×8×5.3 mm³ (Typ.)	8×8×5.3 mm³ (Typ.)	8.4×10.3×5.1 mm³ (Typ.)	8.4×16.0×5.1 mm³ (Typ.)
Remark	Mechanical shutter	VGA 30 fps	VGA 15 fps		Connector on board

System-on-chip FM Radio ICs for Miniature Cell Phones

An adjustment-free FM radio function can be included with absolutely no external components.
Since an ultraminiature $5.0 \times 5.0 \times 0.8$ mm^3 package is used, this device is extremely useful for including an FM radio function in cell phones, PDAs, memory audio players, and other portable electronic equipment.

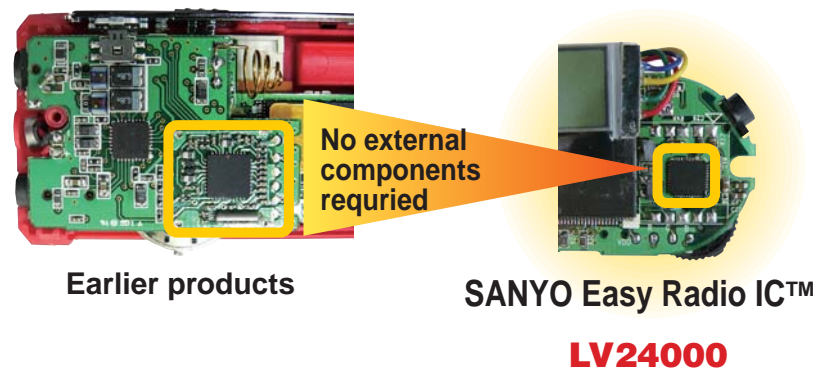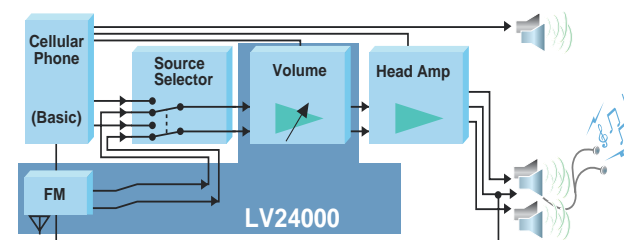FM Radio IC

Easy Radio IC™   LV24000 Series   New product

The LV24000 family devices are FM radio ICs that require absolutely no external components.*
These devices include not only the FM radio function, but source selector, master volume control, tone controls, headphone amplifier, and other functions in the same tiny $5.0 \times 5.0 \times 0.8$ mm^3 VQLP package.
These ICs are superb for adding new FM radio functionality in the small limited space available in existing products, such as cell phones and other portable electronic equipment.

Featuring

- Absolutely no external components required
- Absolutely no adjustments required
- Low IF frequency (110 kHz) adopted for improved selectivity
- No FM detection discriminator required
- Built-in adjacent channel interference function (114 and 190 kHz)
- New tuning technique
- Ultrahigh sensitivity reception achieved by low-noise mixer input circuit
- Low-current standby mode obviates the need for a power supply switch
- RDS composite output
- Three-wire bus interface adopted (clock, data, and NR-W)
- Digital AFC function

- Soft muting and high-blend stereo (3-stage programmable)
- Supports manual search, automatic search, and auto-preset functions
- Supports reception in all regions worldwide (all Japanese, European, and US bands can be received by changing just the software)
- Master volume control
- FM: 76 to 108 MHz
- Source selector function (LV24001)
- Headphone amplifier (LV24002)

**Not only reducing the device prices
but also reducing the various costs during development**

■ Comparison with earlier products

No external components requried

Earlier products

SANYO Easy Radio IC™
LV24000

Including All the Functions
- **FM function (LV24020)**
- **FM+AM function (LV24100)**
- **FM+RDS function (LV24010)**
- **FM+amplifier function (LV24003)**

*: A separate coil is required for applications that include an AM radio
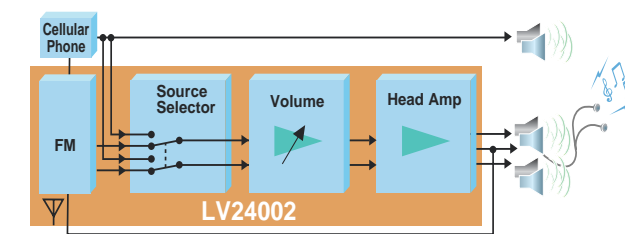
Application Example

Cell phone (1)
LV24000: FM radio function

Cell phone (2)
LV24002: FM radio + source selector + headphone amplifier functions
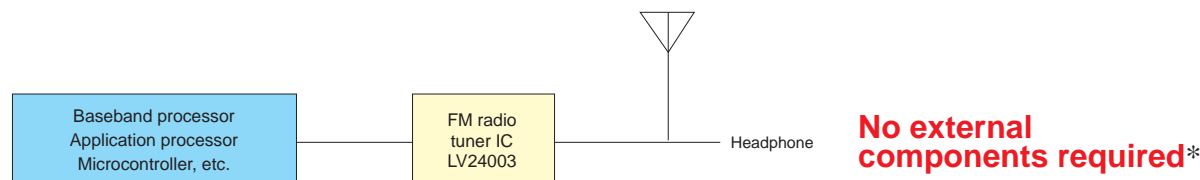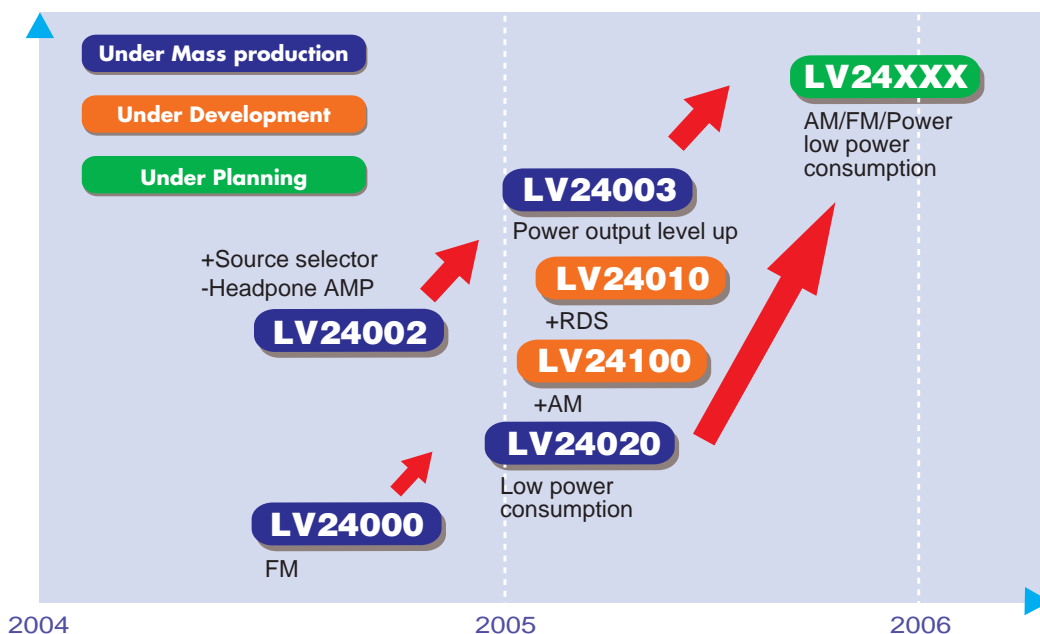

LV24002 Block diagram

System-on-chip FM Radio ICs
Easy Radio IC™ Series

Function and lineup

		LV24000	LV24002	LV24020	LV24100	LV24010	LV24003	LV24200
Function & Spec	FM	Supported	Supported	Supported	Supported	Supported	Supported	Supported
	Master Volume	Supported	Supported	—	—	—	Supported	—
	Tone Control	Supported	Supported	—	—	—	Supported	—
	Beep Generator	Supported	Supported	—	—	—	Supported	—
	Source Selector	—	Supported	—	—	—	Supported	—
	Headphone Amplifier	—	4mW at 32Ω	—	—	—	10mW at 32Ω	—
	AM	—	—	—	Supported	—	—	—
	RDS Demodulator	—	—	—	—	Supported	—	—
	uP I/F	3 wire	3 wire	3 wire	3 wire	3 wire	3 wire	I^{2}C/SPI/ 3 WIRE
	Tuning	Soft	Soft	Soft	Soft	Soft	Soft	Self
	Icco	18mA	22mA	14mA	14mA	14mA	20mA	14mA
Schedule	MP	Available	Available	Available	Available	Available	Available	Available
Package	VQLP40	Supported	Supported	Supported	Supported	Supported	Supported	Supported
	TSSOP24	Supported	—	T.B.D	T.B.D	T.B.D	T.B.D	T.B.D

Baseband processor
Application processor
Microcontroller, etc.

FM radio
tuner IC
LV24003

Headphone

No external components required*￼

SANYO Easy Radio IC Road Map

Under Mass production
Under Development
Under Planning

LV24XXX
AM/FM/Power low power consumption

+Source selector
-Headpone AMP

LV24003
Power output level up

LV24002

LV24010
+RDS

LV24100
+AM

LV24020
Low power consumption

LV24000
FM

2004 2005 2006

This is **what has changed** since the earlier products!
Three points about the **Easy Radio IC™**

No external components required *
Makes cost reductions possible

Miniature package
Ultraminiature
$5 \times 5 \times 0.8$ mm^3 size
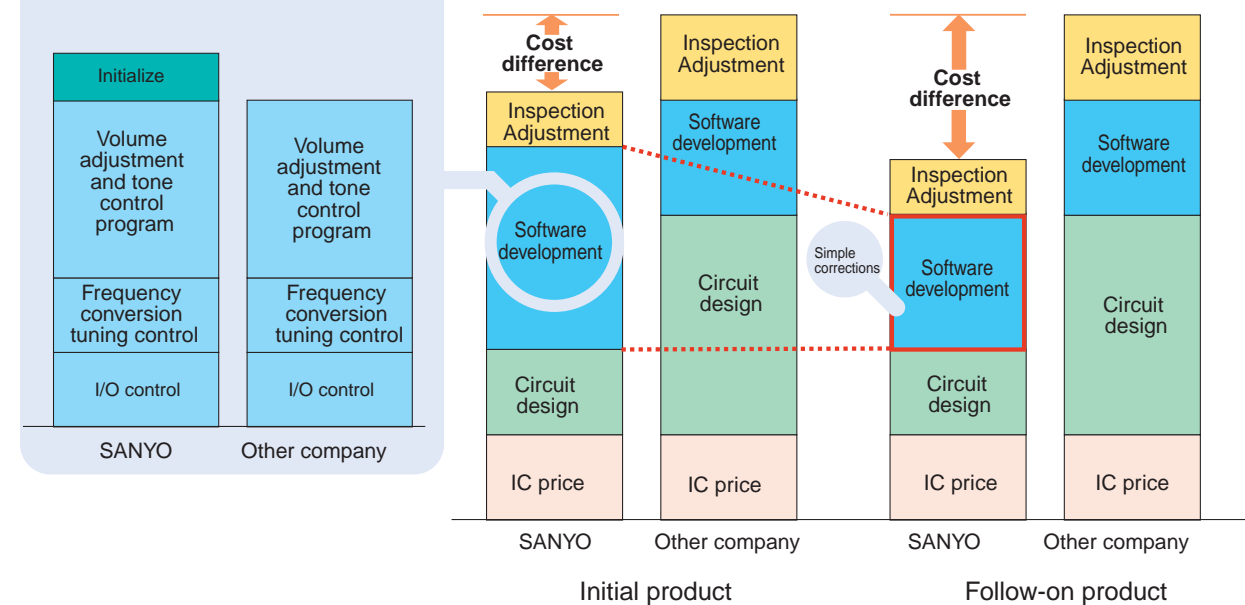
High-sensitivity reception
Achieves clear audio

Changing Total Costs

1. The analog circuit design technology (know-how based on long experience) that has been necessary up to now is no longer required.
2. Although even more time will be required to create the initialization block during software development, this block will be able to correct product sample-to-sample variations, radically **reducing the testing and adjustment during the manufacturing process**, and as a result, reduce total costs.
   Furthermore, since software once developed can be reused in later products, this effort is not wasted.

Comparison of software development costs

Itemized comparison of software development costs
Although the first initialization is required, this can correct for product sample-to-sample variations.

Initialize

Volume adjustment and tone control program

Volume adjustment and tone control program

Frequency conversion tuning control

Frequency conversion tuning control

I/O control

I/O control

SANYO Other company

Cost difference

Inspection Adjustment

Inspection Adjustment

Software development

Software development

Circuit design

Circuit design

IC price

IC price

SANYO Other company

Initial product

Cost difference

Simple corrections

Inspection Adjustment

Inspection Adjustment

Software development

Software development

Circuit design

Circuit design

IC price

IC price

SANYO Other company

Follow-on product

SANYO can provide sample software and algorithms to even further reduce the burden on software developers.

*: A separate coil is required for applications that include an AM radio

Sound Generator IC (MIDI)

Audio Compression IC
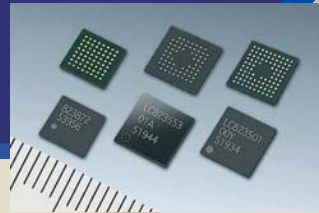
SANYO has developed ICs that, in addition to support for even more sounds, also include new functions such as support for new standard melody formats and 3D audio.

Although previous audio playback periods have been largely limited to 3 to 5 hours, it is now possible to achieve playing times of 24 hours or longer by adopting SANYO audio compression ICs.

Integrates 128-voice polyphony + PCM, 3D surround, 3D positioning* and Mobile XMF support

LC823872
New product

Featuring

● Capable of generating up to 128-voice polyphony in a full PCM sound generator
  128 GM sounds + 47 drum sets + 32 sound effects sounds (conforms to GM1)
● Includes a 3D surround function and a 3D positioning* function that allows the specification of positioning information
  that positions the generated sound at an arbitrary position in three-dimensional space.
● Supports not only the Mobile XMF new melody format but also a variety of other formats
● User Customized Sound function that allows the user to register arbitrary sounds
● Supports up to four songs worth of MIDI data and can play up to four channels of ADPCM (PCM) data at the same time
● Includes a 4-band parametric equalizer that can provide optimal equalization for the speakers used
● Supports karaoke and Java applications: JSR135, JSR2348. Supports special effects such as pitch bend, vibrato, delay,
  reverb, chorus, Doppler, and compression.
● Supply voltage: internal 1.5 V, I/O 1.8 to 2.8 V
● Package: FBGA64 (5×5×1.2 mm)

Integrates 64-voice polyphony + PCM, 3D surround, 3D positioning, Mobile XMF support and MP3/AAC decoding

LC823553
New product

Featuring

● Capable of generating up to 64-voice polyphony in a full PCM sound generator (conforms to GM1)
● Includes a 3D surround function and a 3D positioning* function that allows the specification of positioning information that
  positions the generated sound at an arbitrary position in three-dimensional space.
● Supports not only the Mobile XMF new melody format but also a variety of other formats
● User Customized Sound function that allows the user to register arbitrary sounds
● Supports up to four songs worth of MIDI data and can play up to four channels of ADPCM (PCM) data at the same time
● Includes a 4-band parametric equalizer that can provide optimal equalization for the speakers used
● Supports karaoke and Java applications: JSR135, JSR2348
● Includes an MP3 and AAC decoder function. The industry's lowest power consumption: 8.5 mW for both MP3 and AAC
● Built-in 8-band graphic equalizer
● Supply voltage: internal 1.8/1.3 V, I/O 2.85 V
● Package: WL-CSP64 (6.1×6.1×0.9 mm^3)

Integrates 64-voice polyphony + PCM, 3D surround and MP3/AAC decoding

LC823501
New product

Featuring

● Capable of generating up to 64-voice polyphony in a full PCM sound generator (conforms to GM1)
● Integrated 3D surround function that creates a rich feeling of spaciousness
● Includes an MP3 decoder function. The industry's lowest power consumption: 8.5 mW for MP3
● User Customized Sound function that allows the user to register arbitrary sounds
● Supports up to four songs worth of MIDI data and can play up to four channels of ADPCM (PCM) data at the same time
● Includes a 4-band parametric equalizer that can provide optimal equalization for the speakers used
● Supports karaoke and Java applications: JSR135
● Supply voltage: internal 1.8/1.3 V, I/O 2.85 V
● Package: PFBGA89 (6.0×6.0×0.8 mm^3)

*: 3D positioning function
  Function that can create a realistic
  impression of space even from cell
  phones that cannot provide an
  adequate speaker separation.

MP3/WMA Decoder

LC823231

Featuring

● Ultralow power (MP3: 10 mW, WMA: 15 mW)
● Supported formats
  - MPEG1, MPEG2, MPEG2.5 (all sampling frequencies, all bit rates)
  - WMA
● Digital volume and tone control circuits
● Digital equalizer and audio leakage prevention functions (D/A converter based)
● Δ∑D/A converter and class D amplifier
● PCM I/O interface
● Sleep mode
● Crystal oscillator frequency: 16.9344 MHz (44.1 kHz × 384)
● Sampling frequencies other than 44.1 kHz supported with built-in PLL circuit


Single-Chip Audio

LC82335X
Under development

The LC82335X ICs support MP3, AAC, and AAC+.

By implementing the MP3, AAC, and AAC+ decoding functions in a hardwired structure, these ICs achieve an ultralow power consumption that would be impossible in a DSP based structure.

● Hardwired MP3, hardwired AAC, and hardwired
  AAC+.
● Ultralow power consumption: 10 mW
● Buffer size: 10 KB
● Built-in YY filter
● SD interface
● ARM7TDMI
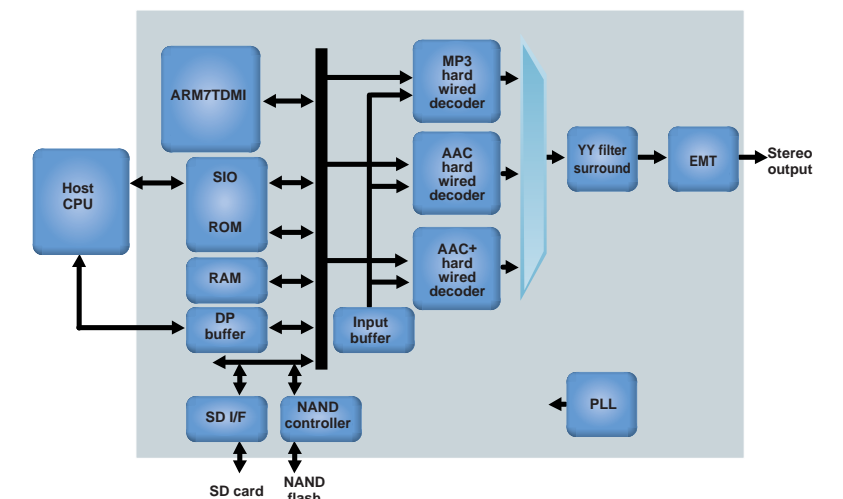
Terrestrial Digital One-Segment Chipset

Miniature reception modules with low power consumption that achieve stable reception under rapidly changing conditions are required for cell phones and other portable terminals. SANYO has established independently developed diversity synthesis technology and the industry's first direct conversion technology that together meet these requirements.
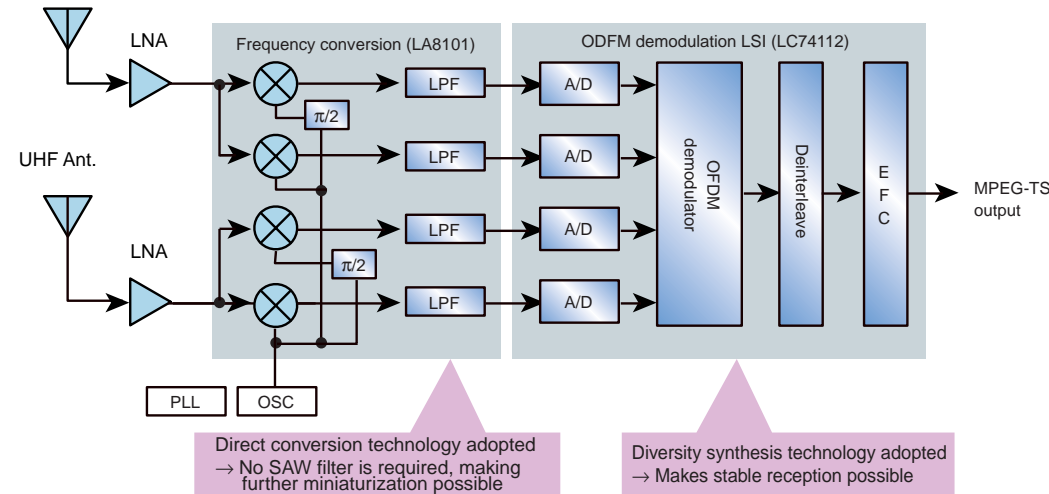
Direct conversion technology adopted
→ No SAW filter is required, making further miniaturization possible

Diversity synthesis technology adopted
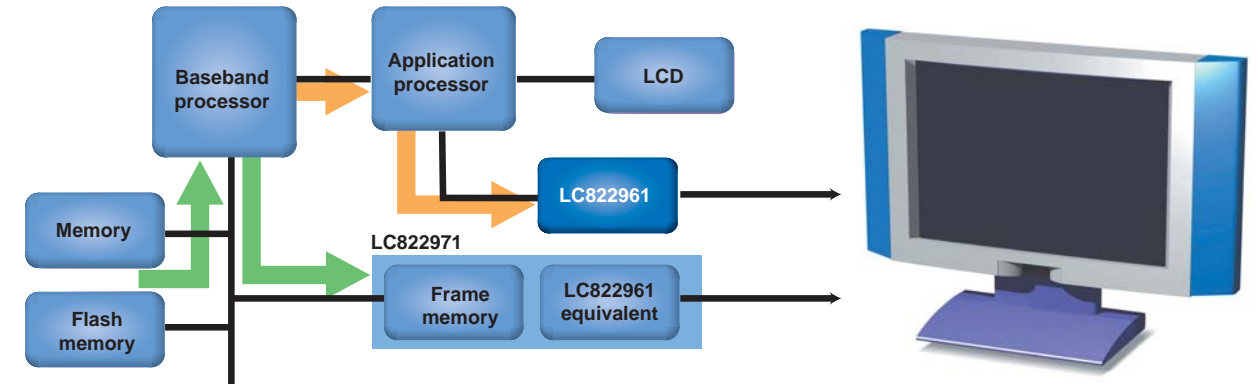→ Makes stable reception possible

Due to the adoption of direct conversion technology
• Large external components such as a SAW filter are not required
• Image cancellation using analog circuits is no longer required, and at the same time as reducing the size of the circuit and the power consumption, circuit performance does not degrade over time or due to temperature fluctuations.

This approach achieves antenna diversity, which is effective at improving reception performance.

Cell Phone Video Drivers

Video driver
LA73074CL
New product

● No output coupling capacitors required
● Low-voltage drive (2.7 to 3.6 V)
● Voltage sag does not occur
● Built-in sixth-order low-pass filter (fc = 7.5 MHz)
● Standby mode power consumption: 0 μA
● The amplifier gain can be selected (6, 9, or 12 dB)

NTSC/PAL Video Encoder

This IC makes it possible to display the cell phone's LCD screen contents or image data that was taken with the camera and is stored in the camera's memory on a TV (video input).

NTSC/PAL Encoder
LC822961
LC822963
New product

Converts base band processor generated video and provides other functions for TV output.
● Miniature package (CSP42: 3.3 × 3.78 mm^2)
● 10-bit D/A converter with built-in 75Ω driver
● Supports a wide variety of input data rates (ITU-R601/SQ)
● The LC822963 is an MCP package version of the LC822961 audio operational amplifier (LA6358N).
● Application examples: TV games, video players
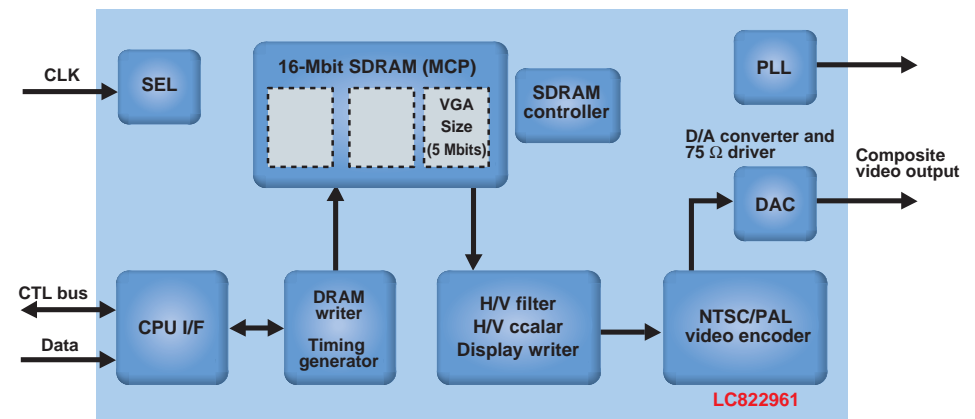
NTSC/PAL Encoder with On-Chip DRAM
LC822971
Under development

Data written to memory can be continuously output to a TV without being sequentially updated using the internal frame memory.
Once the data has been written it can be displayed with essentially no load on the microcontroller.
● On-chip 16 Mbit SDRAM. Allows drawing by the CPU without concern for the TV display rate.
● Rotation processing (at write), enlargement processing (at display)
● The NTSC/PAL encoder block is the same as that in the LC822961.
● Application examples: Photograph album shows, business presentation tools
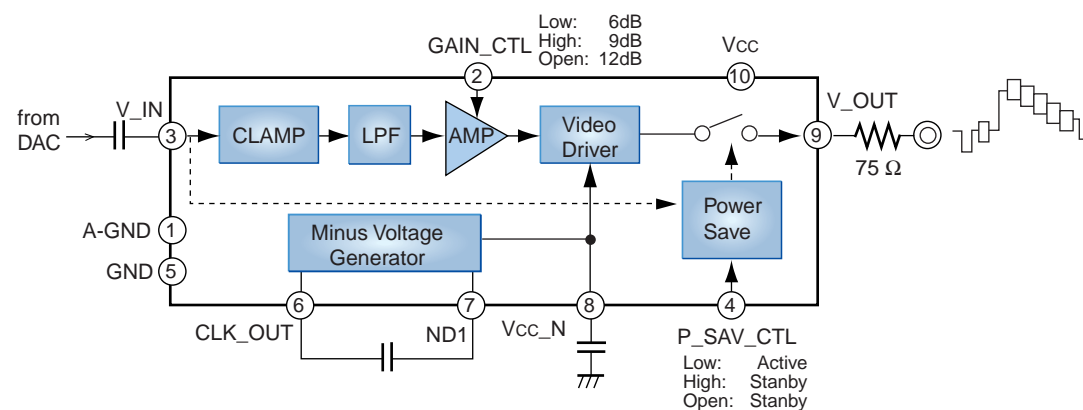
Earphone Mic Solutions
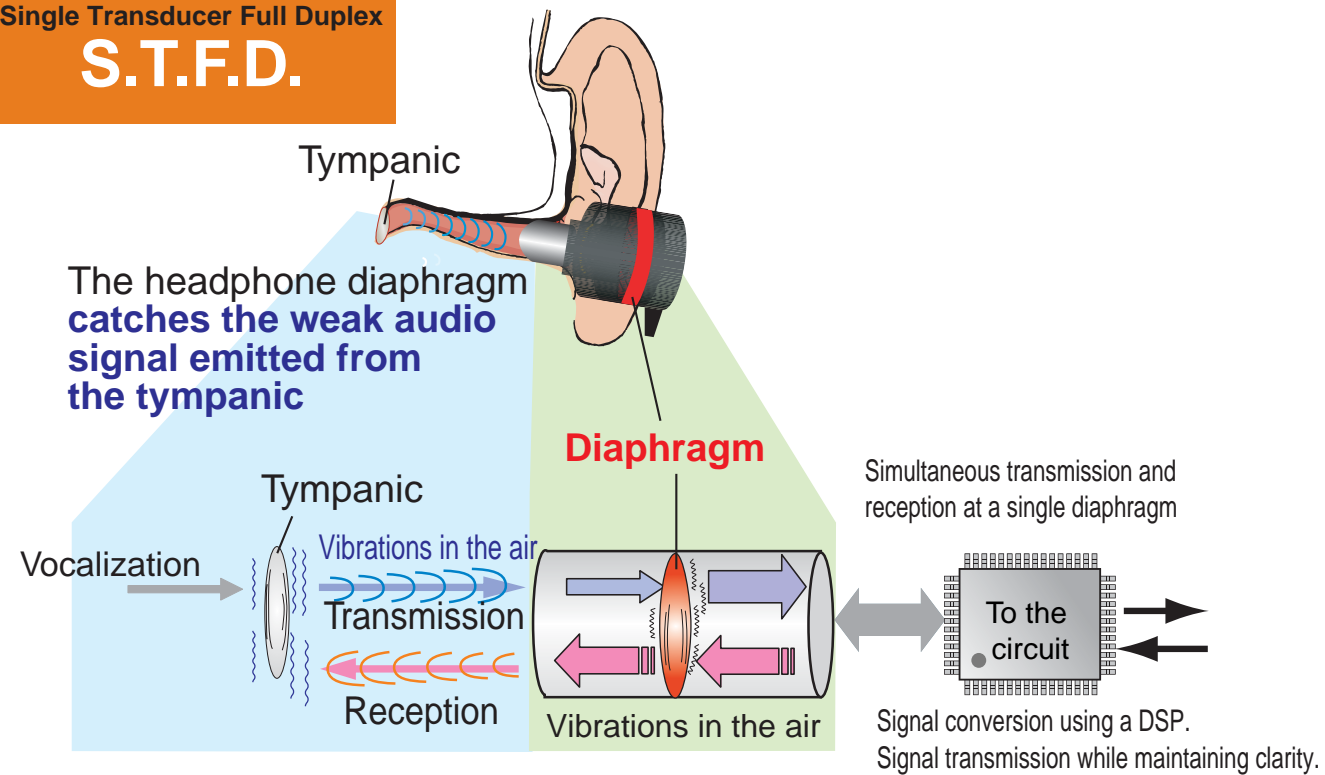
Under development

What is an earphone mic?

SANYO is developing a chip that can support phone conversations with just an earphone.
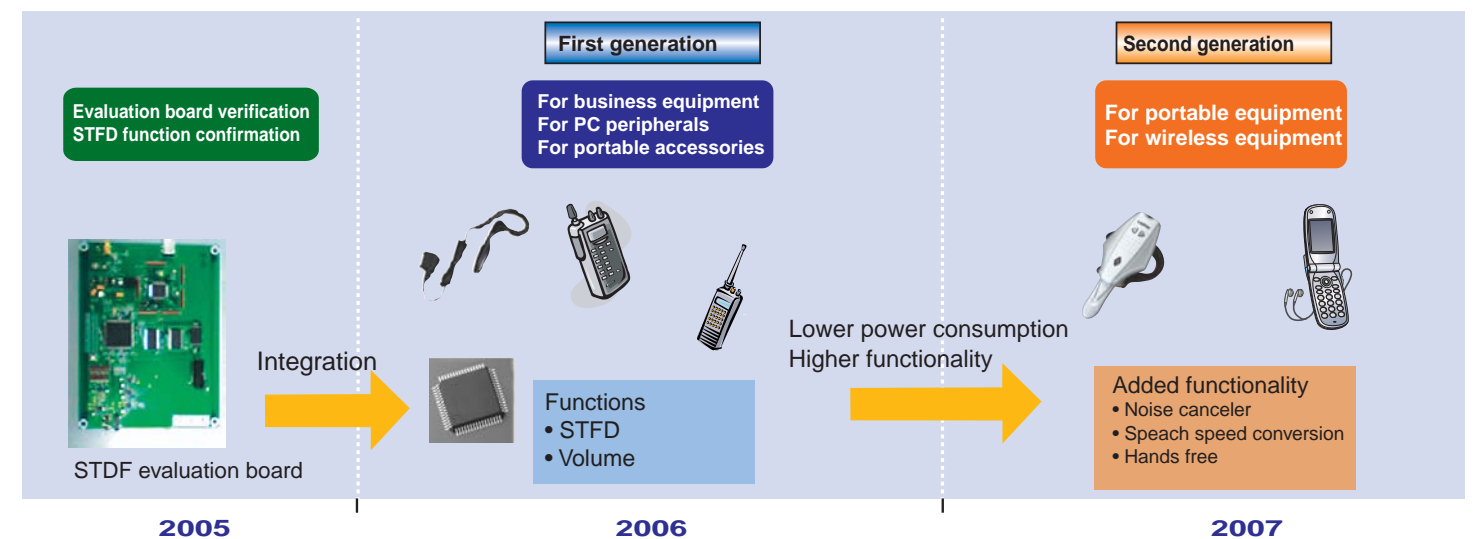
Conversation is possible without taking off your earphones.

- **STFD (single transduce full duplex) technology makes a separate microphone unnecessary!**
  Increased flexibility in end product design
- **Phone conversions are possible even in crowds or noisy environments**
  Since the sound is picked up directly in the ear, wind and other sounds can be reduced.
- **Better audio quality than bone conduction microphones**
  Since an even clearer voice sound is possible, it is easy to identify the speaker.
- **New applications in various other wireless markets**
  Phone conversations are possible without removing one's earphones when listening to music.

Single Transducer Full Duplex
S.T.F.D.

Tympanic

The headphone diaphragm **catches the weak audio signal emitted from the tympanic**

Diaphragm

Tympanic

Vocalization

Vibrations in the air

Transmission

Reception

Vibrations in the air

Simultaneous transmission and reception at a single diaphragm

To the circuit

Signal conversion using a DSP.
Signal transmission while maintaining clarity.

Wind sounds

Higher audio quality

Bone conduction microphones

Earphone mic

Noise is reduced

Hands free

There are also new applications

Resistant to noise

Development roadmap

First generation

Second generation

Evaluation board verification
STFD function confirmation

For business equipment
For PC peripherals
For portable accessories

For portable equipment
For wireless equipment

STDF evaluation board

Integration

Functions
• STFD
• Volume

Lower power consumption
Higher functionality

Added functionality
• Noise canceler
• Speach speed conversion
• Hands free

2005

2006

2007

LED Driver ICs

SANYO provides LED drivers that support automatic gradation production using full-color LEDs and can provide high-capacity outputs up to a total of 500 mA using a switching power supply technique as well as white LEDs for backlights using a charge pump method optimal for white LEDs.

Switching power supply LED drivers

These are LED drivers that can provide a high-capacity output up to a total of 500 mA using a switching power supply technique, and cover applications such as main LCD backlights, sub-LCD backlights, camera flash systems, and full-color LED indicators.
Gradation production using full-color LEDs is also supported (automatic).

LV5202PL
Under development

- 13-channel 9-lamp LED driver
  (Main LED: 4, Sub RGB: 1, Lighting LED: 3, Singe RGB:1)
- Supports 3-color backlights appropriate for simply monochrome displays for sub-displays.
- Switching power supply technique: Can provide up to 500 mA output
- Supports I^{2}C bus
- Ultraminiature package:QFN32 (4.0×4.0×1.0 mm^3)

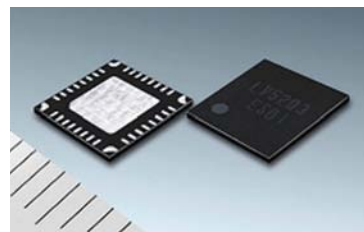Automatic blinking (color changing) in hardware is possible

3ch
3ch
MAIN
SUB
CAMERA
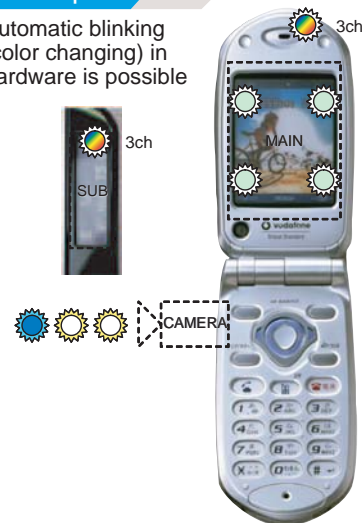
9 LEDs	2 RGB AUTO	Switching 500 mA	I^{2}C

LV5203FN
Under development

- 13-channel 11-lamp LED driver
  (Main LED: 4, Sub LED: 2, Lighting LED: 4, Singe RGB: 1)
- Switching power supply technique: Can provide up to 500 mA output
- Three-wire serial bus support
- Ultraminiature package:VQFN32 (5.0×5.0×0.85 mm^3)

11 LEDs	1 RGB AUTO	Switching 500 mA	3-wire Serial

LV5204PL
Under development

- 13-channel 11-lamp LED driver
  (Main LED: 4, Sub LED: 2, Lighting LED: 4, Singe RGB: 1)
- Switching power supply technique: Can provide up to 500 mA output
- Supports I^{2}C bus
- Ultraminiature package:VQLP32 (4.0×4.0×0.85 mm^3)

VQLP32

11 LEDs	1 RGB AUTO	Switching 500 mA	I^{2}C

Drivers for 3-color LEDs that have an external control interface

LV5213PL
Under development

- 3-channel 1-lamp LED driver (Singe RGB: 1)
- Switching power supply technique: Can provide up to 80 mA output
- Three-wire serial bus support
- Ultraminiature package: VCT16 (2.6×2.6×0.85 mm^3)

1 LED	1 RGB AUTO	Switching 80 mA	3-wire Serial

Charge pump type LED driver

This is a 4-lamp white LED driver for main LCD backlights that allows the brightness to be adjusted with an external PWM input.
Generates the optimal voltages for white LEDs with a high-efficiency charge pump type step-up circuit.
Can provide a constant current output up to a total of 140 mA.

LC410591
Under development

- 4 channels (Main LED:4)
- Charge pump power supply technique: Can provide up to 104 mA output
- Supports brightness adjustment over a serial data input (10 steps)
- Power saving mode
- Soft start function
- Input voltage 2.7 to 5.5 V
- Ultraminiature package:VQFN16 (4.0×4.0×0.85 mm^3)

4 LEDs	Charge pump 104 mA	3-wire Serial

LC410592
Under development

- Two groups for a total of 7 channels (Main LED: 4, Sub LED: 3)
- Charge pump power supply technique: Can provide up to 140 mA output
- Supports brightness adjustment using an external PWM input (input for each group)
- Automatic switching between 1× and –0.5× step-up modes
- Power saving mode
- Soft start function
- Input voltage 2.7 to 5.5 V
- Ultraminiature package:VQFN16 (4.0×4.0×0.85 mm^3)

7 LEDs	Charge pump 140 mA	PWM Control

New Charge Pump ICs

This IC is based on a unique SANYO idea and is a high-efficiency charge pump IC that was newly-developed taking advantage of CMOS technologies that fuse SANYO's circuit and process technologies. This IC is optimal for power supplies in portable electronic equipment.

This IC introduces technologies that completely overturn the previous common knowledge that although charge pump circuits were low noise, they suffered from poor efficiency.

Features of New Charge Pump ICs

CCD image sensors require a high drive voltage of 10 to 20 V. This 10 to 20 V level is created by stepping up the 3 V power supply level.

Since conventional charge pump voltage step-up technologies suffer from increased power loss when used to step up the original voltage by over three times, their use in cell phones was problematic.

SANYO has, however, discovered a way of fusing their high level analog circuit and device technologies to overcome this problem.
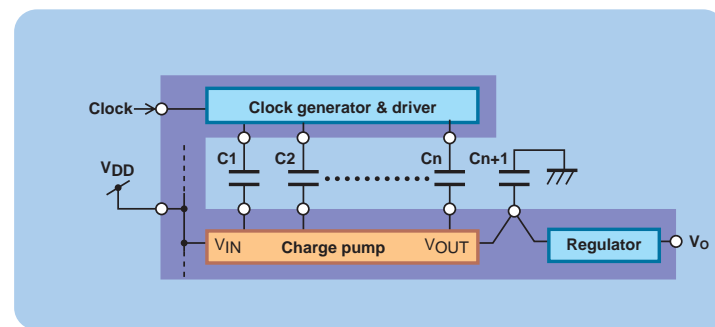
This new charge pump technology can step up a regulated voltage by a factor of three or higher with an efficiency as high as 70%. Furthermore it can provide an output current of several tens of mA.

SANYO was the first in the industry to develop a high-performance charge pump.

This new charge pump technology can provide both positive and negative stepped up levels, can be combined into multiple stages, and can provide multiple output levels. Thus this circuit technology is optimal for use in future camera cell phones that include a megapixel-class CCD image sensor.
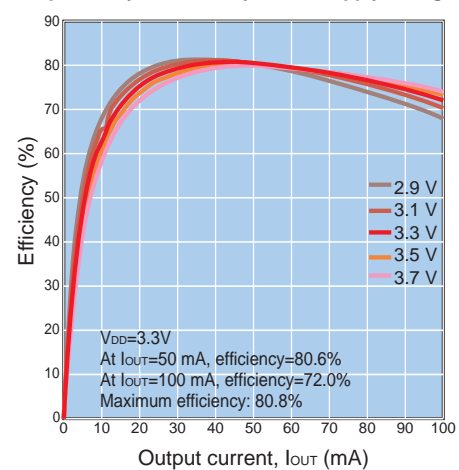
- High efficiency
  (Prior to the regulator: 90 to 95 %)
- Coilless, low noise
- Supports high output current designs
- The only external components are thin form capacitors (no coils or diodes required)
- Can provide both positive and negative stepped-up outputs
- Supports fine step-up step sizes
  $+0.5 \times n \times V_{DD}$
  $-0.5 \times n \times V_{DD}$ (n: integer)
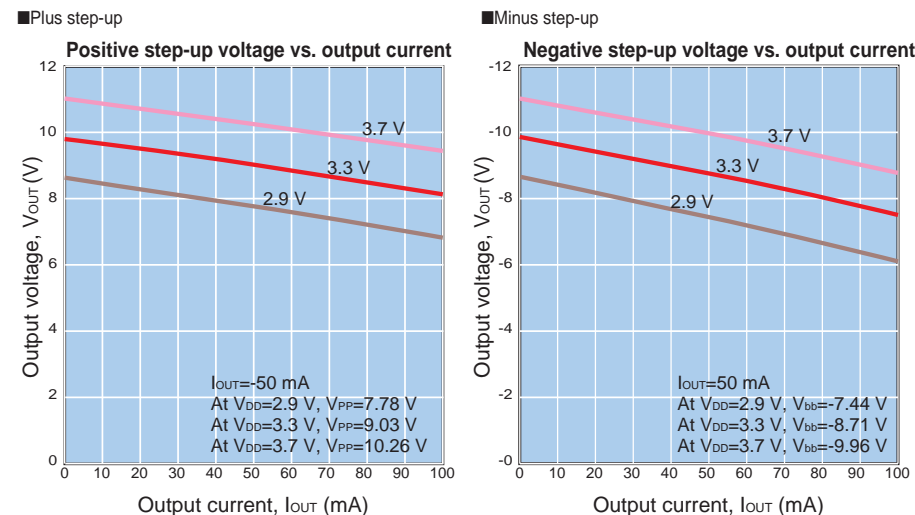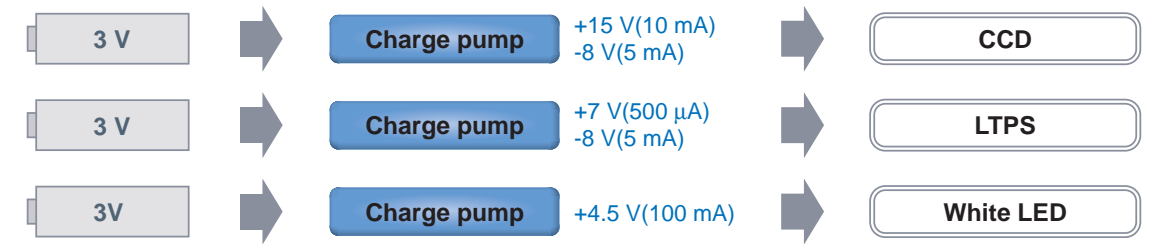- Optimal for use as the power supply in portable equipment

IPBlock diagram

Sample characteristics of a high-current charge pump (single supply voltage→±3×)

Dependency of efficiency on the supply voltage

2.9 V
3.1 V
3.3 V
3.5 V
3.7 V

V_{DD}=3.3V
At I_{OUT}=50 mA, efficiency=80.6%
At I_{OUT}=100 mA, efficiency=72.0%
Maximum efficiency: 80.8%

Output voltages from positive and negative step-up operation

■Plus step-up

Positive step-up voltage vs. output current

3.7 V
3.3 V
2.9 V

I_{OUT}=-50 mA
At V_{DD}=2.9 V, V_{PP}=7.78 V
At V_{DD}=3.3 V, V_{PP}=9.03 V
At V_{DD}=3.7 V, V_{PP}=10.26 V

■Minus step-up

Negative step-up voltage vs. output current

3.7 V
3.3 V
2.9 V

I_{OUT}=50 mA
At V_{DD}=2.9 V, V_{bb}=-7.44 V
At V_{DD}=3.3 V, V_{bb}=-8.71 V
At V_{DD}=3.7 V, V_{bb}=-9.96 V

Charge pump power supply application

The ability to provide a stepped-up voltage with low noise makes this circuit optimal for embedding in modules.

3 V	→	Charge pump	+15 V(10 mA) −8 V(5 mA)	→	CCD
3 V	→	Charge pump	+7 V(500 µA) −8 V(5 mA)	→	LTPS
3V	→	Charge pump	+4.5 V(100 mA)	→	White LED

CCD Power Supply IC for Camera Cell Phones

LV5711FN

Under development

- Regulates a 3.3 to 4.5 V battery level to 3.1 V and steps up that level 3× and 6× using a charge pump, to provide the two regulated power supply levels required by the CCD image sensor.
  • VH = +15.0 V
  • VL = -8 V
- Two independent charge pump systems are provided for VH and VL
- Built-in regulators for the analog system power supply, vertical driver system, and DSP core

Block diagram
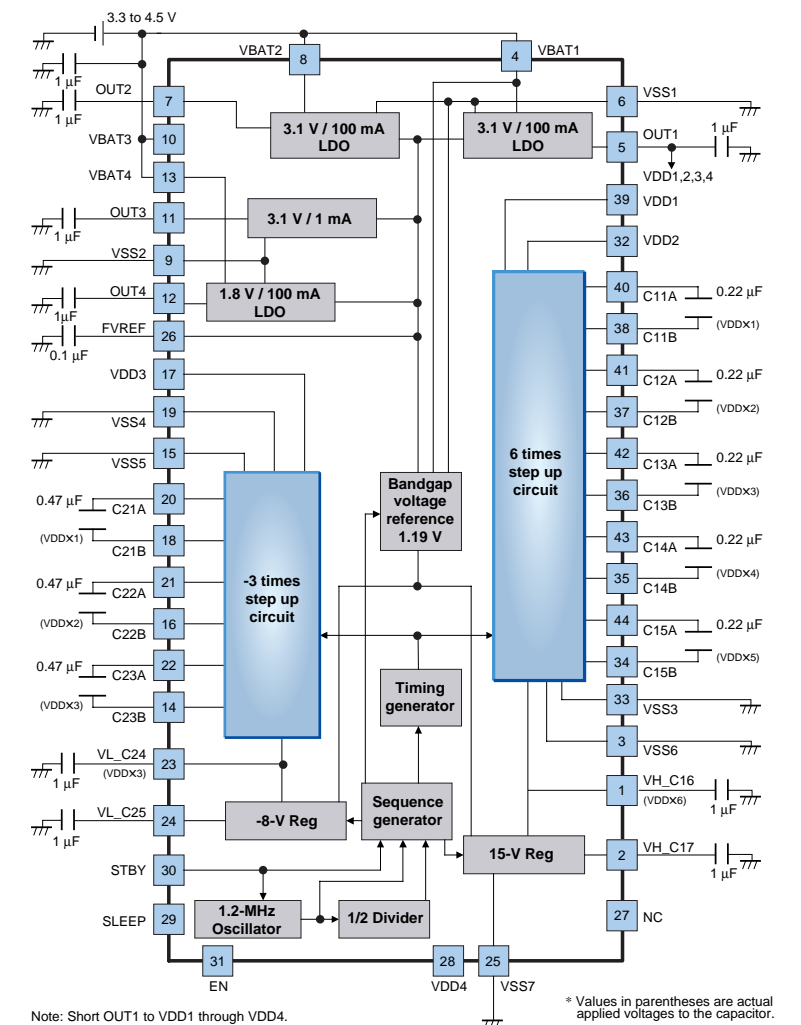
Note: Short OUT1 to VDD1 through VDD4.

* Values in parentheses are actual applied voltages to the capacitor.

Motor Drivers for Cell Phones

Demand for camera cell phones is increasing rapidly not only in Japan, but in most markets around the world as well.
While compact, high image quality cameras are in demand in the cell phone market, there are also increasing desires for high-level camera functions such as mechanical shutters and autofocus.
SANYO developed even further their motor driver technologies nurtured through years of experience in the digital camera field and provides these technologies for use in camera cell phones as ultraminiature package motor drivers that require few external components.

Motor Driver ICs for Cell Phones

Miniature Driver Series

■ **Camera Cell Phone Driver Lineup**

Shutter	Iris diaphragm	Focus	Zoom

Voice Coil Motor
- LB1941T/CL Constant Current
- LB1938T/CL 800 mA
- LB8681CL New product Constant Current 1.5 ch

Stepping Motor (2-phase excitation)
- LB1801CL New product Comp.IN
- LB1801CL New product Comp.IN
- LB8682PL Constant Current 1 ch + 2 ch
- LB8686PL Under development 1.5 ch × 2

Stepping Motor (1-2 phase excitation)
- LB1800CL Comp.IN
- LB1800CL Comp.IN

PIEZO (SIDM)
- LV8071LG Under development

Lens Driver IC for Cell Phones

LB1906CL

For Auto-Focus Motors

Saturated control and 1-2 phase excitation drivers

Block diagram

Two-phase excitation motor drivers

LB1801CL — New product

For autofocus and zoom

- ● Supports an FR position detection output
- ● Low saturation voltage output
- ● Two-phase excitation driver
- ● Low-voltage drive
  Drive is possible from 2.2 V

Compact Package

12-pin 2.8 mm □ Package

Block diagram

Constant current driver with H bridge × 1.5 ch

LB8683CL — Under development

For Shutter and Iris Diaphragm System

Block diagram

Auto Foucus Piezo actuator

LV8071LG — Under development

For Auto-Focus Motors

Block diagram

Amorphous Optical Sensors

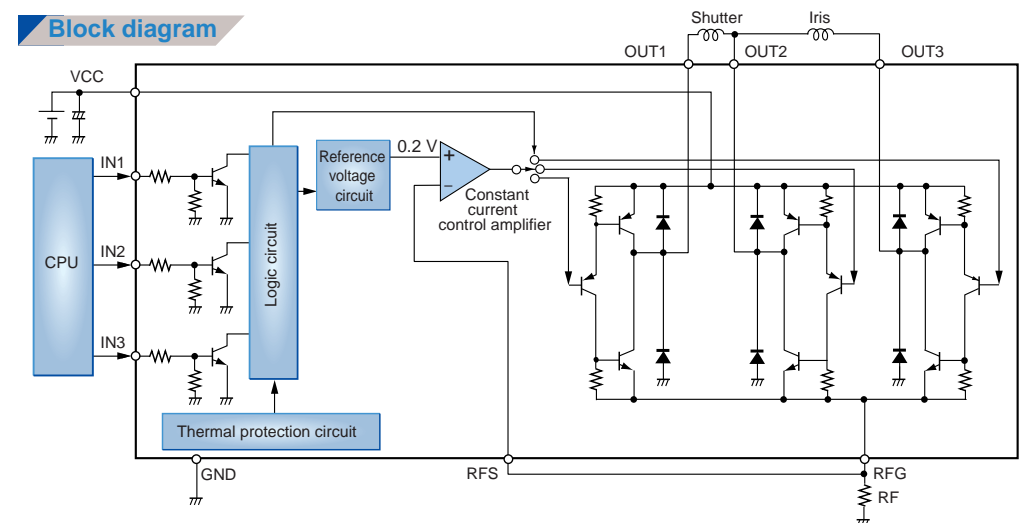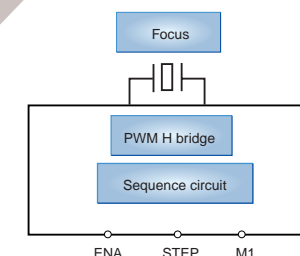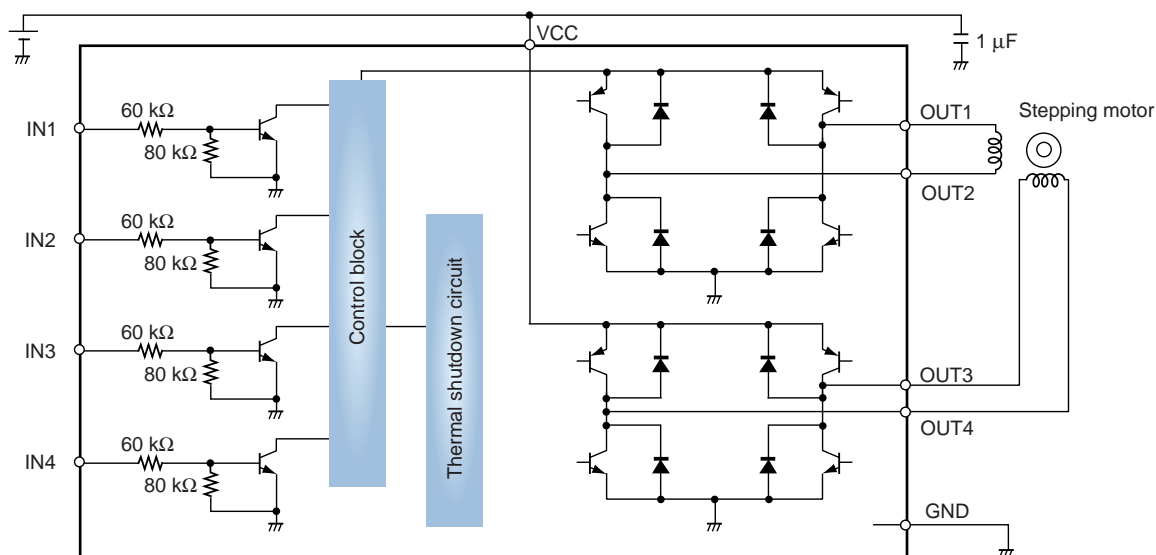These devices are a type of photodiode that can detect light with about the same sensitivity as the human eye. Since these devices flexibly support a wide range of end product designs and sizes, they can be used to control the LCD backlight and button lamps in cell phones to implement power saving automatic brightness adjustment
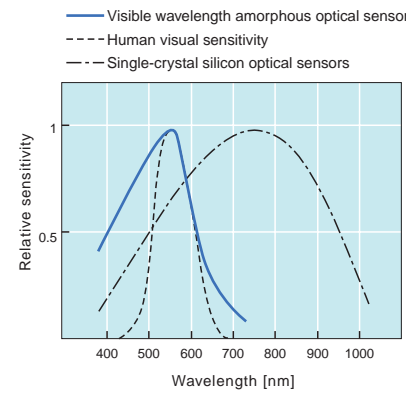
Amorphous Silicon Solar Cells

Amorphous Optical Sensors

These devices are a type of photodiode that can detect the presence/absence of ambient light, or the intensity of ambient light.
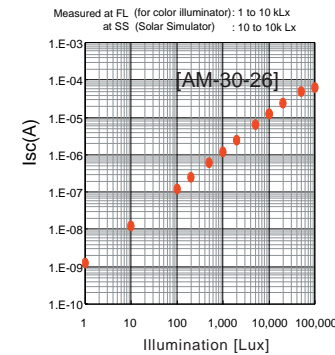
Amorphous optical sensor spectral sensitivity

— Visible wavelength amorphous optical sensor
---- Human visual sensitivity
-·-· Single-crystal silicon optical sensors

(Y-axis: Relative sensitivity, X-axis: Wavelength [nm], 400–1000)

High sensitivity in the visible region

The human eye is sensitive to light with wavelengths from about 400 nm to about 700 nm. Since these amorphous optical sensors have sensitivity to essentially the same wavelengths, they provide sensing that is close to that of the human eye.

Illumination-dependent characteristics of ISC

Measured at FL (for color illuminator): 1 to 10 kLx
at SS (Solar Simulator) : 10 to 10k Lx

[AM-30-26]

(Y-axis: Isc(A), 1.E-03 to 1.E-10, X-axis: Illumination [Lux], 1 to 100,000)

The output current is proportional to the illumination

Since the output current changes proportionally to the light striking the sensor, these devices provide precise detection.
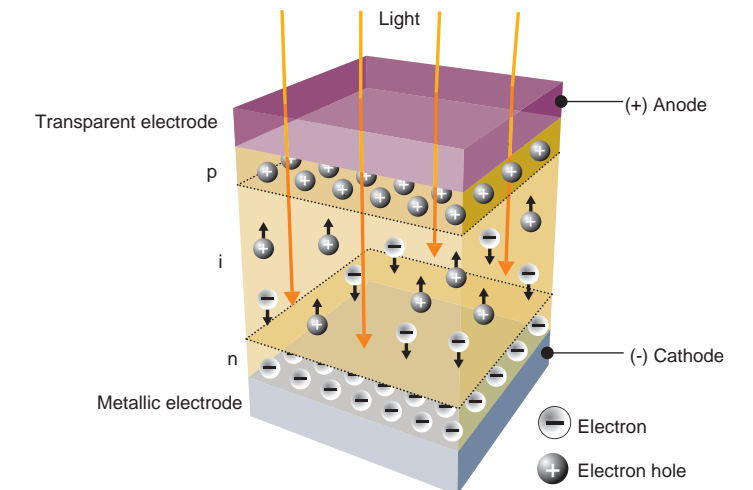
Amorphous optical sensor pattern examples

2.1
1.2
2.0
0.88
0.84

[AM-30-26]
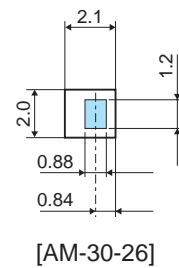
Flexible pattern geometries and sizes

These devices support designs with sizes and shapes that correspond to the target application.

Amorphous Optical Sensor Application Examples

Automatic adjustment of LCD backlight and operating panel buttons

These sensors can be used to sense the ambient illumination level and automatically turn off these lamps in bright operating environments. This reduces unnecessary power consumption and creates LCD screen display that is easy to see whatever the ambient lighting.

● Increased operating time for portable electronic equipment due to reduced power consumption!
● LCD backlight level automatically adjusted to just the right level for viewing according to the ambient illumination level

Bright environments   Dark environments

LCD backlight

OFF Automatic brightness adjustment ON

Button lamps

Cell phone with built-in optical sensor

Bright environments   Dark environments

LCD backlight OFF   LCD backlight ON   LCD backlight ON

About 300Lx   About 3Lx

Button lamps OFF   Button lamps OFF   Button lamps ON
5 to 20mA   55 to 70mA   95 to 110mA
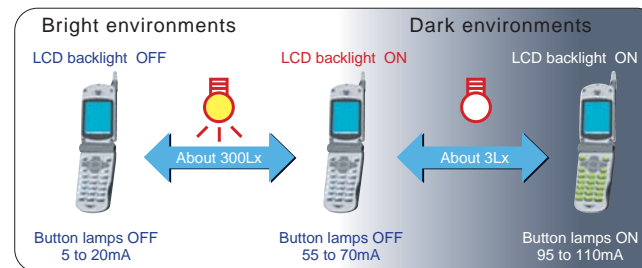
Cell phone without built-in optical sensor

Bright environments   Dark environments

LCD backlight ON   LCD backlight ON   LCD backlight ON

Unnecessary power   Unnecessary power
consumption occurs   consumption occurs

Button lamps ON   Button lamps ON   Button lamps ON
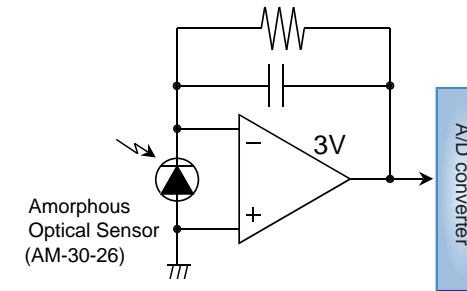95 to 110mA   95 to 110mA   95 to 110mA

Amorphous Optical Sensor Structure

Like amorphous silicon solar cells, amorphous optical sensor use the photovoltaic effect in semiconductors. When light hits a semiconductor, electrons and holes are created, the electrons diffuse in the n-type semiconductor, and the holes diffuse in the p-type semiconductor. As a result, a current will flow when the two semiconductor types are connected externally.
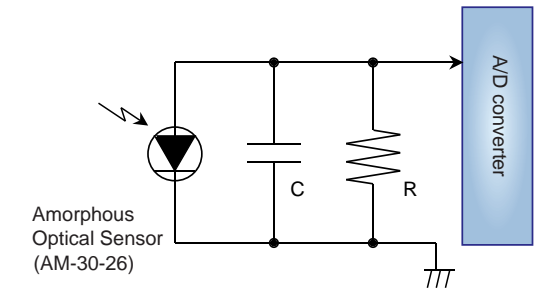
Light
Transparent electrode
(+) Anode
p
i
n
(-) Cathode
Metallic electrode
⊖ Electron
⊕ Electron hole

Amorphous Optical Sensor Circuit Examples

With an operational amplifier

3V
A/D converter
Amorphous Optical Sensor (AM-30-26)

The current output from the amorphous optical sensor is converted to a voltage, and signal processing is applied to that voltage.
Normally, an operational amplifier is used for linear amplification.

Without an operational amplifier

A/D converter
C   R
Amorphous Optical Sensor (AM-30-26)

The amorphous optical sensor is connected to a resistor and the voltage is input directly to an A/D converter for discrimination.

Amorphous Optical Sensor Product Lineup

Type No.	External dimensions (mm)	Short-circuit current (I_{SC}, typical)	Dark current (V_R = 50 mV) MAX.
AM-30-26	2.1 × 2.0 mm^2 (glass thickness: 0.4 mm)	1.2 μA [*1]	10 pA

[*1] : at 1000Lux, Fluorescent Light for color illuminator

Contact your SANYO sales representative for details on these products

Handling More Data Even Faster. Supporting Needs for Higher Performance with Peripheral Components

SANYO's Lineup of High-Reliability Discrete Devices

SANYO supplies high-performance GaAs switching ICs that feature the industry's smallest package size and smallest number of external components. SANYO discrete devices have been always leading the cell phone and mobile equipment markets. SANYO is also developing devices that support the need for higher speeds and larger data capacities for image and video data due to the inclusion of high pixel count cameras in this equipment.

Bipolar Transistor for LNA
Low noise, High gain transistors (f_T=20 GHz)
SBFP405M, SBFP420M...etc.

GaAs MMIC products for antenna switches and local switches
Low insertion loss MMIC / High isolation MMIC
SPM3211, SPM3212, SPM3215, SPM3218...etc.

Devices for Li-ion batteries
Ultralow on-resistance MOSFET series
ECH8601, FTD2017A...etc.
Schottky barrier diodes
SBS804...etc.

Junction FETs for ECM
Ultrathin package: VTFP
TF218TH, TF208TH, TF202(SSFP)...etc.

Devices for CCD camera module
Ultrahigh-frequency transistors
EC3H02B, 2SC5538, 2SC5539...etc.
Schottky barrier diodes
EC2D01B, SB0203EJ...etc.

Bipolar transistor for VCO
Low phase noise transistors
EC3H02B, EC3H09B...etc.

Transistors for LCD backlight circuits
Precise interface control MOSFETs
5LN01S, 5LP01S
MCH6614(2 in 1)...etc.
Complex devices
MCH5809, CPH5809(MOS + SBD)...etc.

Power management switches
Ultralow on-resistance MOSFET series
VEC2301, SCH2602, ECH8603
MCH6307...etc.

LCD backlight ultralow saturation voltage transistors

Ultralow saturation voltage transistor development roadmap

Low saturation voltage transistor generation map

Ultralow on-resistance MOS devices for power management

Low and medium output MOS device development roadmap
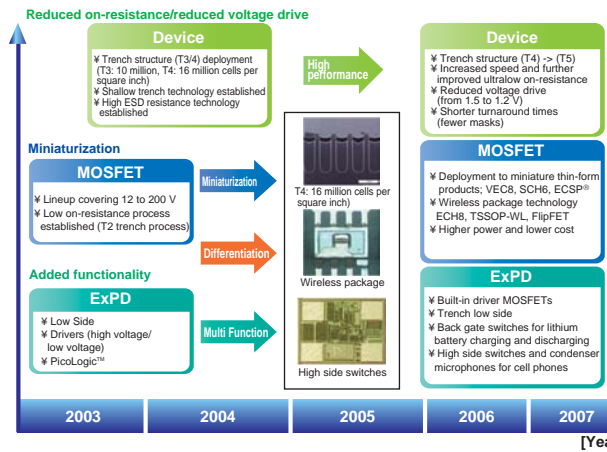
Ultralow on-resistance MOS device generation map

Low VF/IR Schottky barrier diodes for power management

Low V_F/I_R Schottky barrier diode development roadmap

$V_F – I$ comparison data for earlier and low-V_F devices Schottky barrier diodes

- Low forward voltage
- Miniature thin-form package

Contributes to
increased efficiency, miniaturization, and thinner form factors
in end products!

SANYO's Lineup of High-Reliability Discrete Devices
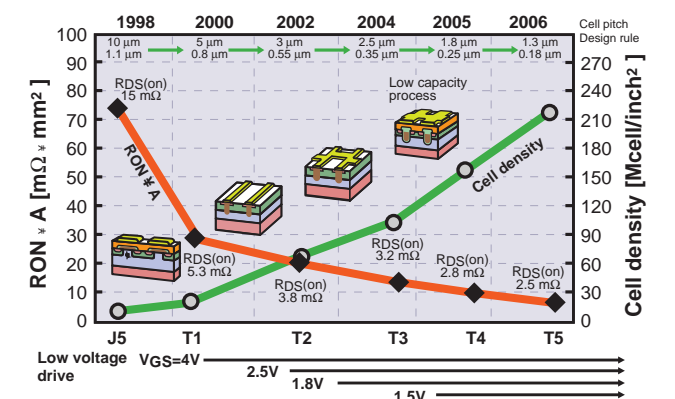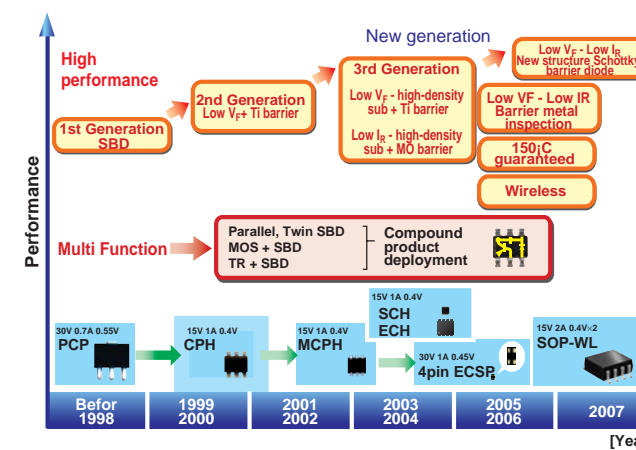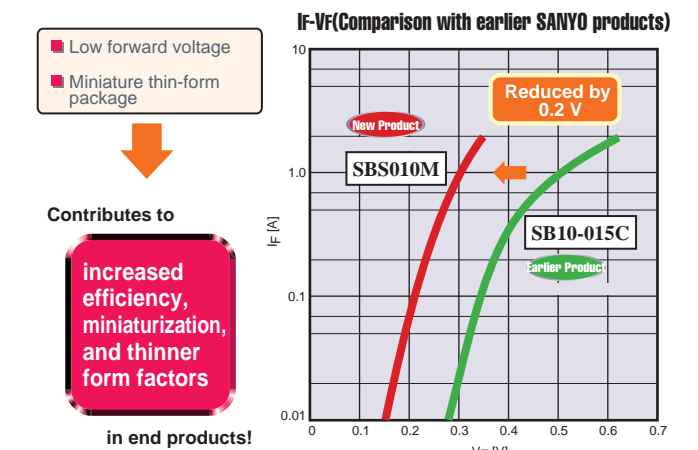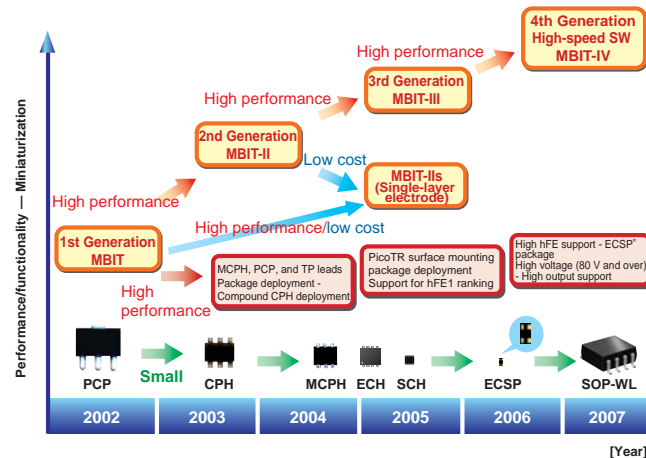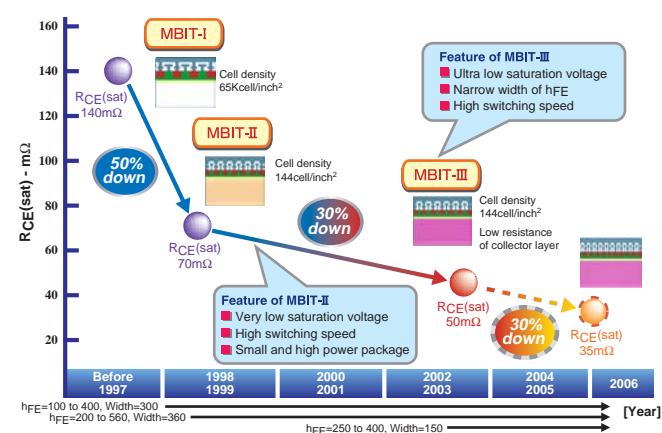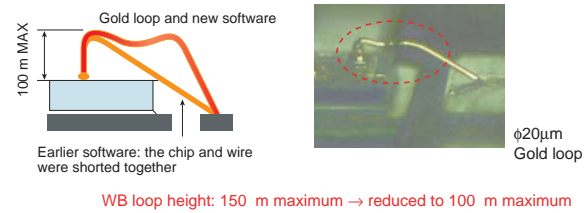
SANYO supplies high-performance GaAs switching ICs that feature the industry's smallest package size and smallest number of external components. SANYO discrete devices have been always leading the cell phone and mobile equipment markets. SANYO is also developing devices that support the need for higher speeds and larger data capacities for image and video data due to the inclusion of high pixel count cameras in this equipment.
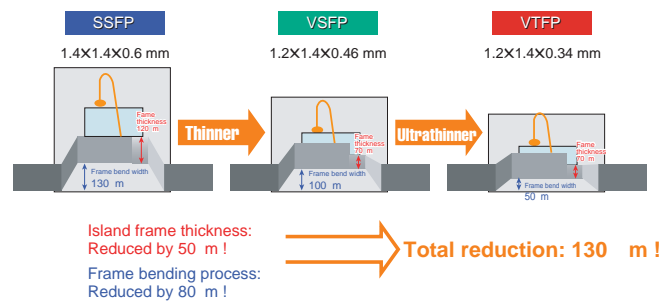
FETs for Cell phone ECM
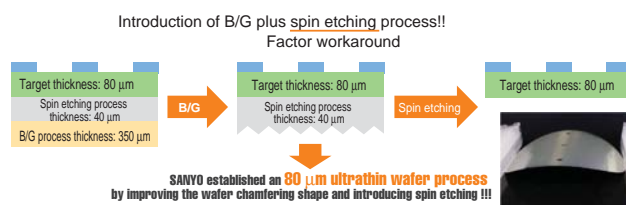
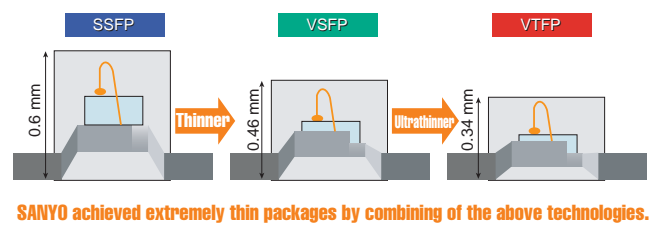### Thin-form package technology

Gold loop and new software (M loop)

100 m MAX

Gold loop and new software

Earlier software: the chip and wire were shorted together

φ20μm Gold loop

WB loop height: 150 m maximum → reduced to 100 m maximum

Thinner island frame and improved frame bending process

SSFP	VSFP	VTFP
1.4×1.4×0.6 mm	1.2×1.4×0.46 mm	1.2×1.4×0.34 mm

Thinner → Ultrathinner

Frame bend width 130 m

Frame bend width 100 m

Frame bend width 50 m

Island frame thickness: Reduced by 50 m !
Frame bending process: Reduced by 80 m !

Total reduction: 130 m !

Establishment of and ultrathin wafer process (4 inch)

Introduction of B/G plus spin etching process!!
Factor workaround

Target thickness: 80 μm
Spin etching process thickness: 40 μm
B/G process thickness: 350 μm

B/G →

Target thickness: 80 μm
Spin etching process thickness: 40 μm

Spin etching →

Target thickness: 80 μm

SANYO established an 80 μm ultrathin wafer process by improving the wafer chamfering shape and introducing spin etching !!!

Total package height

SSFP	VSFP	VTFP
0.6 mm	0.46 mm	0.34 mm

Thinner → Ultrathinner

SANYO achieved extremely thin packages by combining of the above technologies.

High signal-to-noise ratio technology

JFET noise component

Condenser microphone JFET structure

JFET
Source pad
Gate sub
Drain pad
Protective diode static voltage workaround
Polysilicon resistor transient characteristics workaround
Drain
Gate
Source

The high resistance polysilicon resistor (1 to 3 GΩ) used to stabilized the gate-source potential accounts for a large portion of the JFET noise component.

Result

Noise voltage (dBV) vs R_{GS} (GΩ)
Smaller / Larger

Gate voltage (V) vs Potential stabilization time (s)
2 GΩ / 25 GΩ / 90 GΩ

Development

Improved signal-to-noise ratio due to p-channel MOSFET development

Input protection diode
Input protection resistor
GND
V_{DD}
V_{IN}
Pch MOSFET
L / W = 3 μm / 1 mm

V_{DD}
V_{DD} protection resistor
300‰
V_{IN} 1k‰
GND

Effect
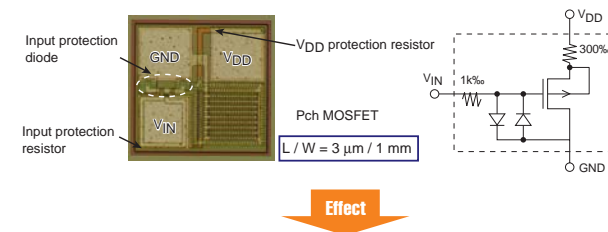
	Noise voltage (dBV)	Insertion loss (dBV)	Signal-to-noise ratio (dB)	Signal-to-noise ratio evaluation
Pch MOSFET	-113 to -114	-5.0 to -5.5	68 to 68.5	◎
JFET	-105 to -107	-1.5 to -3.5	62 to 64	○

Enhancement mode P-ch MOSFET Potential stabilization time

Potential stabilization time
Vin Voltage (V) vs Time (s)
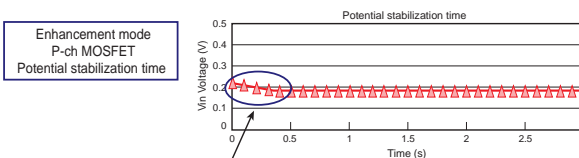
The potential stabilization time becomes under 1 second in enhancement mode p-channel MOSFETs.

Digital Cell Phone 0.8 GHz, 1.5 GHz

Inner antenna
Whip antenna
Antenna switch
Low-noise amplifier
Antenna switches(GaAs MMIC) SPM3212 SPM3215 SPM3220 SPM3226
Power amplifier
Filter switches (GaAs MMIC) SPM3212 SPM3220 SPM3226
Buffer amplifiers EC3H10B FS303 FS304
OSC(NPN BiP) EC3H09B, EC3H07B SBFP420B
Local switches SPM3212 SPM3220 SPM3226
(Pch MOS) MCH6305/MCH6307 ECH8603
Li-ion Battery (Pch MOS) ECH8601 ECH8603
(Pch MOS) MCH6305/MCH6307 ECH8603
Baseband logic

CDMA/TDMA (IS136)

Ext.
Inner antenna
Antenna
Antenna switch
Diversity switches (GaAs MMIC) SPM3212 SPM3215 SPM3220 SPM3226
Low-noise amplifier
Filter
Mixer
Duplexer
Buffer amplifiers (NPN BiP) EC3H10B FS303 FS304
OSC(NPN BiP) EC3H09B EC3H07B SBFP420B
Local switches (GaAs MMIC) SPM3212 SPM3220 SPM3226
Filter switches for TDMA (GaAs MMIC) SPM3211 SPM3212
Filter switches for TDMA (GaAs MMIC) SPM3212 SPM3220 SPM3226
PA module
Filter switches for PCS and TDMA SPM3212, SPM3220, SPM3226

PHS

Inner antenna
Antenna
Low-noise amplifiers
EC3H07B EC3H10B SBFP405B SBFP420B SBFP540B
Diversity switch
Antenna switches SPM3212 SPM3215 SPM3220 SPM3226
Power amplifier
Buffer amplifiers (NPN BiP) EC3H07B FS303
OSC EC3H09B EC3H07B SBFP420B
Local switches (NPN BiP) SPM3212 SPM3220 SPM3226
Li-ion battery
Baseband logic
CPH3106(PNP Bip.), MCH3106(PNP Bip.) MCH6305(Pch MOS) MCH6307(Pch MOS)
CPH3106(PNP Bip.) MCH3106(PNP Bip.) MCH6305(Pch MOS)

SANYO's Lineup of High-Reliability Discrete Devices

As miniaturization and efficiency advance and improve in portable equipment, the needs for further miniaturization and lower power consumption in discrete devices are increasing even faster.

SANYO responds to these needs by providing an extensive line of products that contribute to reduced mounting areas and reduced parts counts in application circuits

Microwave Device Series

● High-frequency silicon transistors for VCO

Usage	Type No.	Package	Size (mm)	f_T typ. (GHz)	V_{CEO} (V)	I_C (mA)	P_C (mW)	N_F typ.(dB)	$\|S21e^2\|$ typ.(dB)	Notes
Oscillator	EC3H09B	ECSP	1.0 × 0.6	11.2	4	70	100	1.5	6	
	EC3H11B	ECSP	1.0 × 0.6	10.5	4	80	100	1.5	5	
	SPFP420B	ECSP	1.0 × 0.6	25	4.5	35	100	1.1	17	
	SPFP540B	ECSP	1.0 × 0.6	29	4.5	80	100	0.9	8.5	
	2SC5781	SSFP	1.4 × 0.8	11.2	4	70	100	1.5	6	
	2SC5783	SSFP	1.4 × 0.8	10.5	4	80	100	1.5	5	
Buffer	EC3H07B	ECSP	1.0 × 0.6	12.5	4	30	100	1.5	10.5	
	EC3H10B	ECSP	1.0 × 0.6	12.5	4	40	100	1.3	8.5	
	2SC5646	SSFP	1.4 × 0.8	10	4	30	100	1.5	9.5	
	2SC5782	SSFP	1.4 × 0.8	12.5	4	40	100	1.3	8.5	
Oscillator + Buffer	FS301 (TR1 Side)	ECSP	1.2 × 0.8	12.5	4	30	100	1.5	10.5	2SC5645
	(TR2 Side)			25	4.5	35	100	1.1	17	SBFP420
	FS303 (TR1 Side)	ECSP	1.2 × 0.8	12.5	4	30	100	1.5	10.5	2SC5645
	(TR2 Side)			11.2	4	70	100	1.5	8.5	2SC5781
	FS304 (TR1 Side)	ECSP	1.2 × 0.8	12.5	4	40	100	1.3	10.5	2SC5782
	(TR2 Side)			11.2	4	70	100	1.5	8.5	2SC5781

● GaAs MMIC products for Antenna switches, local switches and other switches

Usage	Type No.	Package	Size (mm)	Control Voltage (V)	Isolation typ.(dB)	Insertion Loss typ.(dB)	Pin1dB typ.(dBm)	Notes
Switch	SPM3220	ECSP	1.2 × 0.8	3	**16	**0.5	§26	0.4 to 2.5 GHz Use
	SPM3226	ECSP	1.2 × 0.8	2.4 to 5	**18	**0.35	§22(2.8V)	0.4 to 2.5 GHz Use
	SPM3227	ECSP	1.2 × 0.8	2.4 to 5	**18	**0.35	§22(2.8V)	0.4 to 2.5 GHz Use
	SPM3211	MCPH6	2.1 × 2.0	3	**16	**0.55	§28	0.4 to 2.5 GHz Use
	SPM3212	MCPH6	2.1 × 2.0	3	**16	**0.55	§28	0.4 to 2.5 GHz Use
	SPM3215	MCPH6	2.1 × 2.0	3	**13	**1.1	§26	0.4 to 2.5 GHz Use
	SPM3501	MCPH6	2.1 × 2.0	3	■13	■1.0	□20	Up to 6 GHz Use

SPM3211: Reverse control IC of SPM3212
SPM3215: Single control IC
SPM3226: Reverse control IC of SPM3227

** Measured frequency: 2.5 GHz § Measured frequency: 1 to 2.5 GHz
■ Measured frequency: 5.8 GHz □ Measured frequency: 5 to 6 GHz

Power MOSFETs+ Schottky Barrier Diodes for logic block

Type No.	Package	Size (mm)	V_{DSS} (V)	I_D (A)	P_D (W)	$R_{DS(on)}$ VGS=2.5V max. (Ω)	V_{RRM} (V)	I_O (A)	V_F max. (V)	I_R max. (μA)
MCH5801	MCPH5	2.1 × 2.0	20	1.5	0.8	280m	15	0.5	0.45	200
MCH5815	MCPH5	2.1 × 2.0	12	1.5	0.8	450m	15	0.5	0.45	200
CPH5802	CPH5	2.8 × 2.9	20	2	0.9	200m	15	1	0.4	500
CPH5811	CPH5	2.8 × 2.9	20	3	0.9	82m	15	1	0.4	500

Ultralow on-resintance Power MOSFETs for RF and logic block

Type No.	Package	Size (mm)	V_{DSS} (V)	$R_{DS(on)}$ VGS=4.5V Max. (Ω)	$R_{DS(on)}$ VGS=2.5V Max. (Ω)	$R_{DS(on)}$ VGS=1.5V Max. (Ω)	I_D (A)	C_{iss} typ(pF)	Polarity
SCH1302	SCH6	1.6 × 1.6	20	*0.165	0.22	○0.39	2	410	Pch
SCH2601(Pch) (Nch)	SCH6	1.6 × 1.6	30	*1.9	2.8	—	0.4	40	Pch+Nch
			30	*0.9	1.15	—	0.7	30	
SCH2602(Pch) (Nch)	SCH6	1.6 × 1.6	12	0.31	0.47	0.67	1.5	160	Pch+Nch
			30	*3.7	5.2	—	0.35	7	
3LP03M	MCP	2.1 × 2.0	30	*1.9	2.8	—	250m	40	Pch
3LN03M	MCP	2.1 × 2.0	30	*0.9	1.15	—	350m	30	Nch
MCH3411	MCPH6	2.1 × 2.0	30	*90m	118m	—	3	270	Nch
MCH6305	MCPH6	2.1 × 2.0	20	65m	98m	—	4	680	Pch
MCH6307	MCPH6	2.1 × 2.0	12	46m	66m	○98m	5	940	Pch
CPH6311	CPH6	2.8 × 2.9	20	42m	60m	—	5	1230	Pch
ECH8603	ECH8	2.8 × 2.9	20	54m	87m	—	4	800	Pch Dual
ECH8611	ECH8	2.8 × 2.9	12	40m	65m	—	5	1230	Pch Dual
VEC2302	VEC8	2.8 × 2.9	30	168m	—	—	3	510	Pch Dual
VEC2303	VEC8	2.8 × 2.9	12	49m	75m	107m	4	940	Pch Dual

*VGS=4V, ○VGS=1.8V

Low saturation voltage transistors for logic block

Type No.	Package	Size (mm)	V_{CEO} (V)	I_C (A)	P_C (W)	h_{FE} Min. to Max.	V_{CE} (sat) Max. (mV)	Porality
15C01S	SMCP	1.6 × 1.6	15	0.6	0.2	300 to 800	300	NPN
30C02S	SMCP	1.6 × 1.6	15	0.8	0.2	300 to 800	280	NPN
SCH2101	SCH6	1.6 × 1.6	12	0.8	0.4	300 to 800	240	PNP
SCH2201	SCH6	1.6 × 1.6	15	0.8	0.4	300 to 800	280	NPN+NPN
SCH2503(PNP) (NPN)	SCH6	1.6 × 1.6	30 / 30	0.6 / 0.6	0.4 / 0.4	200 to 500 / 300 to 800	220 / 190	PNP+NPN
MCH3106	MCPH3	2.1 × 2.0	12	3	0.8	200 to 560	165	PNP
MCH3206	MCPH3	2.1 × 2.0	15	3	0.8	200 to 560	150	NPN
CPH3109	CPH3	2.8 × 2.9	30	3	0.9	200 to 560	230	PNP
CPH3209	CPH3	2.8 × 2.9	30	3	0.9	200 to 560	180	NPN

Schottky Barrier Diodes for logic block

Type No.	Package	Size (mm)	V_{RRM} (V)	I_O (A)	I_{FSM} (A)	V_F max. (V)	I_R max. (μA)	Notes
SS1003EJ	ECSP	1.6 × 0.8	30	1	5	0.45	360	
SB1003EJ	ECSP	1.6 × 0.8	30	1	5	0.55	15	
S0503SH	SCH6	1.6 × 1.6	30	0.5	5	0.47	120	
SS1003M	MCPH6	2.1 × 2.0	30	1	5	0.45	15	
SB1003M	MCPH6	2.1 × 2.0	30	1	5	0.55	15	
SBS004M	MCPH3	2.1 × 2.0	15	1	10	0.4	500	
SBS808M	MCPH5	2.1 × 2.0	15	1	10	0.43	90	Parallel type

SANYO Electric Co., Ltd. www.global-sanyo.com

This catalog provides information as of April, 2006.
Specifications and information herein are subject to change without notice.

Printed in Japan / April 2006 2d OTE